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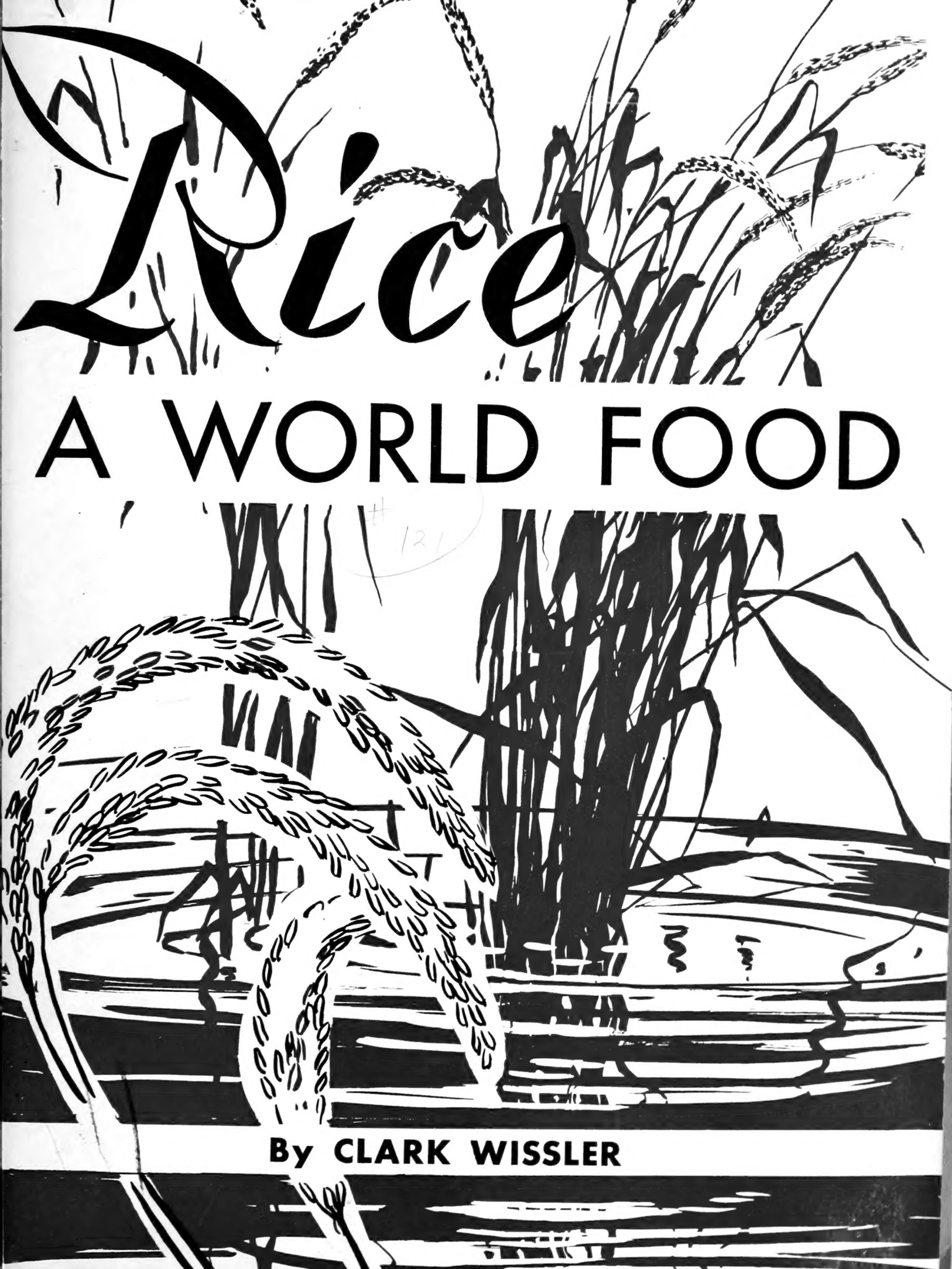
Rice

A WORLD FOOD



By CLARK WISSLER

RICE AS A WORLD FOOD

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Curator Emeritus of Anthropology,
The American Museum of Natural History

MAN AND NATURE PUBLICATIONS

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UNHULLED RICE KERNELS of the variety known as Blue Rose

CULTIVATED RICE

Photos from U. S. Dept. of Agriculture

Rice AS A WO

By CLARK WISSLER

Curator Emeritus of Anthropology, The American Museum of Natural History

RECENTLY two articles appeared in this series stressing the importance of wheat and corn in the development of civilization. We now look at rice, the chief crop in the third great cereal area of the world. When the New World was discovered, corn characterized one such area as shown on the accompanying map. In the Old World we find two fairly distinct areas, a central area dominated by wheat, and a southeastern area devoted to rice. Wheat seems to have been first domesticated in Asia Minor, a dry upland country, whereas rice originated in a tropical, rainy, marshy country. The cultivation of each spread abroad rapidly about as far as its growing habits permitted.

The area devoted to the cultivation of rice is evidence of its importance to man. The number of people who de-

CULTIVATED RICE in the field

Photo from U. S. Dept. of Agriculture

One half of the people of the world consider rice their chief food. To examine its role in human life is to travel far back along the corridors of history

LD FOOD

pend upon it for food is even more impressive. Almost everywhere in Southeast Asia, rice ranks as the main food. Because of the density of population in that part of the world, it is estimated that one half of the human race lives upon rice. The other half of the world's people occupy a much greater area, but for the most part they are bread eaters (wheat, barley, rye, and corn).

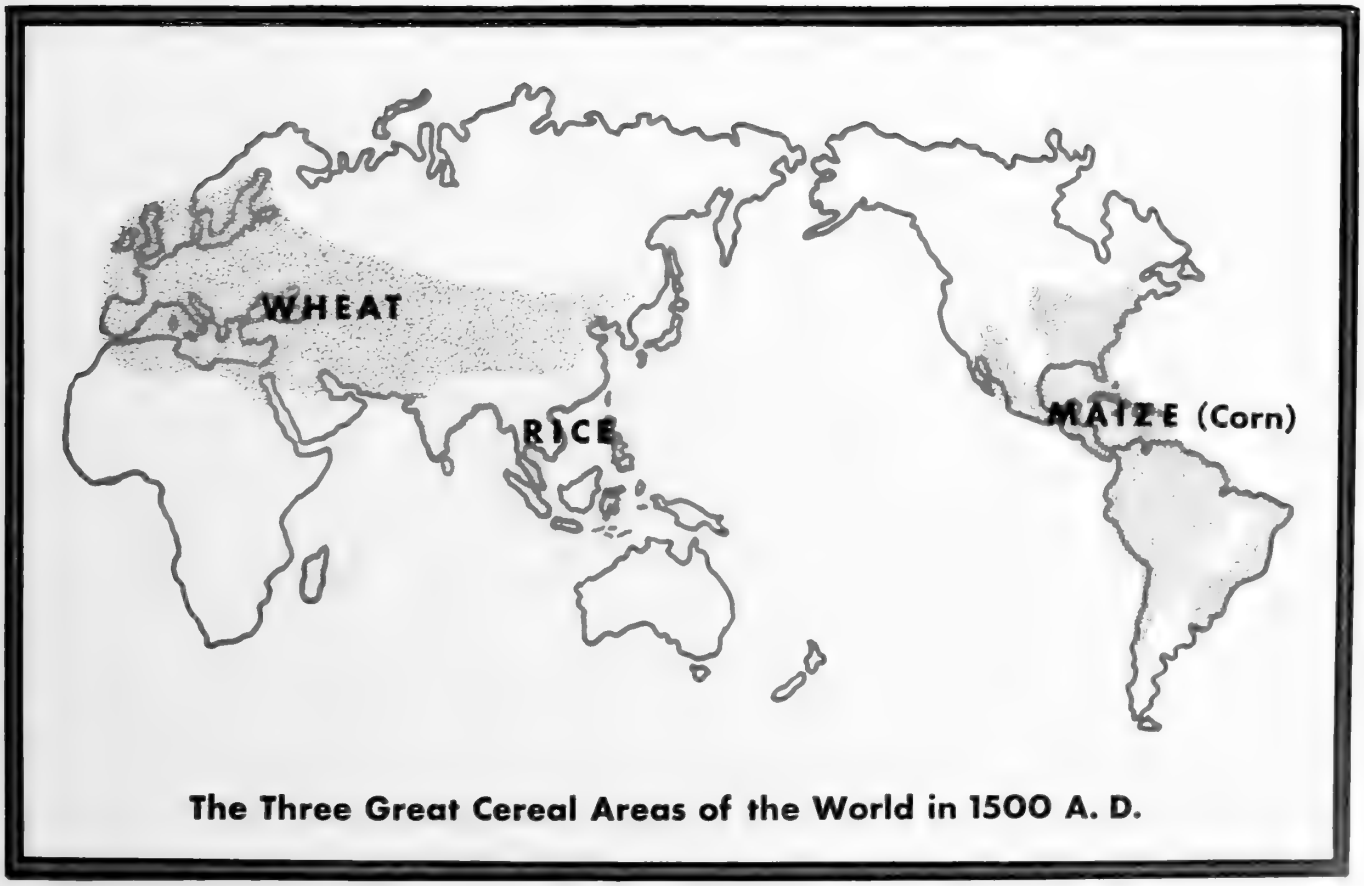
When we think of rice, we think of China, but in India rice plays an even larger role. British India alone, with a population of about 300 million, produces annually about 600 million bushels of rice. We have no good statistics for China with its 400 million people, but it is estimated that she produces less rice than India. Hence, it would be a mistake to rate China as a whole as being fully dependent upon rice, though rice is the chief food in the southern provinces.

In a region like the Philippines, native life is largely organized around the production of rice. Its importance is shown by the special rituals that accompany almost every phase of its cultivation and processing. It is the only food recognized by such ceremonies in the Philippines. As A. L. Kroeber expresses it in his well-known book,* "The native point of view is clearly that if the success of the rice is assured by the necessary magical and ceremonial means, other crops will automatically take care of themselves. When plant food is offered to the spirits in any connection, it is almost invariably rice. In short, the Filipino not only eats rice, but thinks in terms of rice, and if his civilization is to be described in a single phrase it can only be termed a rice culture."

**The Peoples of the Philippines,* page 86. (Handbook 8, The American Museum of Natural History.)

We have noted that there is still some difficulty in identifying the wild ancestors of wheat and corn, but cultivated rice seems definitely to have come from a single species, *Oryza sativa,* native to the East Indies. All rices grown are regarded as varieties of this species, and they are surprisingly numerous. According to some writers, about a thousand varieties of cultivated rice are known in India alone, all of which are special strains, adapted to local differences in soil, temperature, and rainfall. In the main, however, a tropical or at least a subtropical climate is required. The plants are annuals and reach a height of two to five feet, with panicles (seed heads) roughly resembling oats.

The original wild species required low ground that was flooded at least part of the year. The cultivated varieties known as "hill," "upland," or "dryland" rice can be nursed through the growing season without flooding, but the yield is less and the grains smaller than in the aquatic varieties.



The Three Great Cereal Areas of the World in 1500 A. D.

Photo by Lionel Green, from Frederic Lewis

▲ CULTIVATION OF RICE apparently came later in history than wheat. But wild rice was probably eaten in the East Indies long before the plant was domesticated. The only implements the first rice-growers used seem to have been digging sticks and wooden spades. Only after the cultivation of rice spread to the Asiatic mainland and contact was made with people who grew wheat and millet were the plow and draft animals adopted. "Dryland" rice, as distinct from that grown in flooded fields, was probably developed through watching wheat farmers at work

▼ WHEN the field is dry and the rice mature, knives or sickles are used to harvest it. A scene in Bali

Photo by Lionel Green, from Frederic Lewis

Methods of rice farming

One of the regions often chosen to best exemplify aquatic rice-growing is the Malabar coast of southwest India. This coast receives torrential rains in May, June, and July, followed by a period of moderately heavy rains in October. The dry season is from December to March. The

A.M.N.H. photo

AFTER PLOWING, the wet rice field is smoothed by means of a "scraper": a scene in Bali

TRANSPLANTING RICE. Sometimes the seed is sown broadcast, sometimes it is trampled into the mud. Here the young plants are being replanted, near Baguio in the Philippine Islands

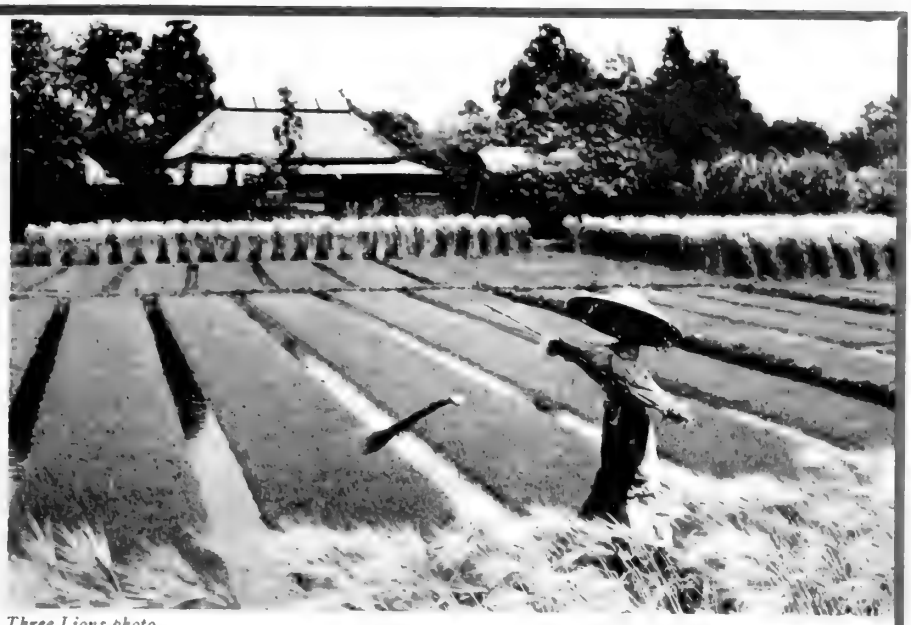
lowlands of the coastal belt vary from 30 to 50 miles wide and are thickly populated by rice-growers. There are 1000 to 2000 inhabitants to the square mile. Originally these lowlands were covered with dense deciduous forests, which were later cleared for rice growing. All the land that can be flooded by impounding rainfall and river water is devoted to rice. Sixty to 120 days are required for a crop, depending upon local conditions. Harvest time is usually in September.

Before the rains begin, a simple pointed plow is used to scratch up the surface of the ground. Water buffaloes are preferred to oxen and are yoked to the plow either singly or in pairs. Cattle dung is spread over the plowed surface, which after the first rains is plowed once more, and the earth is finally smoothed by dragging a log back and forth.

When all is ready, the banks, or dikes, surrounding the field (paddy) are repaired. If the timing has been correct, the rains now begin, and as soon as the ground softens up, the rice seed is sown broadcast, sometimes trampled into the mud, sometimes not. The plants begin to grow in the water-covered soil. At intervals during the growing season, men and women wade into the rice paddy to pull out the intruding weeds. Finally, the water is drained from the paddy

MULTIPLE SCARECROW: an arrangement of lines extending to all portions of the field and jerked as needed from a central tower. This device is used frequently in Hawaii. Constant vigilance is necessary to save the rice crop from birds

Sevda Studio photo



Three Lions photo

▲ A JAPANESE RICE GARDEN

◀ TREADING RICE IN THE PHILIPPINES: the aboriginal method of threshing the world's staple food grains

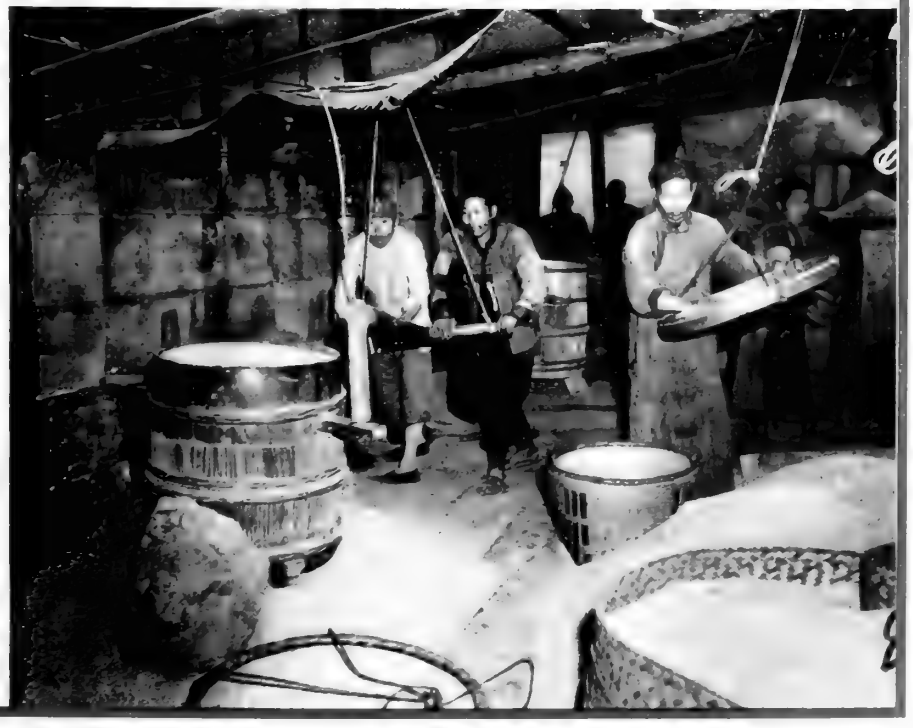
(Fenno Jacobs photo, from Three Lions)

➤ HEAVY WOODEN PESTLES are sometimes used in hulling rice in the Philippines

Theodore Roosevelt, Jr. Collection, A.M.N.H.

▼ THIS VIEW in a Chinese shop in the town of Pishan shows a method of hulling rice that has been in use for centuries

Alexanderson (C N S), from Guillumette, Inc.



to permit the ground to harden. When the rice is mature, the heads are cut from the stalks with various kinds of knives or sickles. Immediately thereafter, millet, pulse, or sesame is sown. Water buffaloes, a few cattle, and sheep and goats are herded upon the wastelands and are fed in part upon rice straw, chaff, and other crop foods, such as millet, oil cake, etc.

Turning from the Malabar coast dwellers to Asiatic and insular rice growers in general, we find that wherever the growing period is short, rice may be sprouted and grown for a time in flooded beds and then transplanted by hand to flooded rice fields. This naturally adds to the labor of rice production.

When the rice grains begin to mature, the fields are raided by seed-eating birds, often in such numbers as to leave but a small harvest. A common method of keeping the birds away is to stretch a number of strings across each paddy, with streamers or pennants attached to them. These flap about when the cord to which they are fastened is jerked vigorously. Small platforms or towers are erected so as to enable a single watcher to guard four plots. This is no small task, because the flock, when disturbed, merely takes wing to descend at another location.

Processing the crop

Threshing rice involves two operations. As in oats, a hull or husk firmly encloses each grain, and this must be removed by rubbing or gently beating the grain in a mortar or upon a mat. The most primitive way is to tread barefoot upon the unhulled grain.

The next step is to separate the detached hulls, or chaff, from the grain by winnowing. The usual way is to scoop the trampled mass into a shallow basket and toss it into the air above a mat or sheet. The heavy grain falls straight down, while the chaff is floated to one side by the gentlest of air currents.

For the most part the hulled grains of rice are not white but are covered with a coat of brown, which can be removed by rubbing or beating, a process called "polishing." However, many native rice-growers dispense with this procedure and eat "brown rice" instead. The food value of rice is decreased by polishing, yet custom regards white rice as preferable.

In the Philippines, as in many other parts of the rice area, hillsides a

Fenno Jacobs, from Three Lions

▲ BEATING RICE to separate the kernels from the husks, in the Philippines

utilized by the construction of terraces, or walled-in shelves, extending horizontally one above the other. These are flooded with water in the rainy season. The magnitude of these terraces, covering the landscape from valley to hilltop like a gigantic series of hanging gardens, is impressive. The prodigious task of keeping them in order means that the owners make rice-growing their chief concern. Hand labor prevails, with the simplest mechanical appliances, — little more than digging sticks, crude wooden shovels, and the bare hands. The plow, first developed by wheat farmers, seems to have been introduced by the Spanish conquerors of the Islands.

Since 1500 A.D. the cultivation of rice has been introduced into many tropical and semitropical areas, such as southern Europe and North Africa, and parts of west Africa, southern United States, certain localities in Mexico, Central and South America, and many Pacific Islands, including Hawaii. The annual production of rice in the United States is about 70 million bushels, or about one-fourth the barley crop. This amounts to about one-half bushel per capita, but since cooked rice expands 300% in bulk, the amount is of some importance.

North American wild rice

Our story would not be complete without some account of wild rice in America. This is a different genus of

▼ AFTER the rice is hulled, it must be winnowed. The kernels fall to earth and the chaff floats away

Alfred T. Palmer photo, from Black Star

➤ THE LABOR of tending hillside rice terraces like these and of keeping the dikes in repair can easily be imagined: a scene in Ifugao Subprovince, Luzon, in the Philippines, where human life revolves about the growing of rice

Theodore Roosevelt, Jr. Collection, A.M.N.H.

rice, *Zizania aquatica* and *Z. miliacea*. *Aquatica* grows in single stems, five to ten feet tall, with panicles about two feet long. The glumes (husks) are about an inch long, containing long slender grains, of a dark slate color when ripe. The plants can adapt themselves to quiet water, two to eight feet in depth, preferably the margins of ponds, lakes, or flood plains of rivers with mud bottoms. Early in June the shoots appear above the water. They mature about August 1st, and the grain is ready for gathering in September. The early French explorers speak of this wild rice as wild oats, Indian oats, etc.

The plant is an annual and seeds itself, since the ripe grains are heavy and sink to the bottom when they fall. The main habitat of *Z. aquatica* is the part of the United States and southern Canada east of the 100th meridian west, an area roughly east of a line passing through Pierre, South Dakota, Dodge City, Kansas, and Abilene, Texas. The Indians who made the most use of wild rice were those of eastern Canada around the Great Lakes and Winnepeg drainage areas, tribes speaking Algonkin and Siouan.

A similar Asiatic species, *Z. latifolio,* has been observed in Siberia, Japan, Formosa, and part of eastern China. Although *Z. aquatica* is reported from the West Indies, it is not known in South America.

None of the North American Indians seem to have *sown* wild rice until after contact with white people. Since 1800, some of them are known to have stocked lakes and ponds when necessary, but once the plant was introduced, it needed no cultivation.

The only attention the early Indians gave the crop was to tie the rice heads in bunches to protect the crop from birds and to prevent the wind from shattering out the grains. For this, they made twine of basswood

WILD RICE, native to North America, was an portant source of food to many Indians. It urished without cultivation in the margins of kes and on the muddy floodplains of rivers d was harvested in September. (Potomac ver)

Fish and Wildlife Service photo

bark fiber. Each woman, or family, used a slightly different tie and accordingly claimed ownership of the ripening rice.

The rice was gathered from canoes, poled or paddled among the rice stalks, the bunches of heads being bent over and the grain beaten off into the boat, as shown in one of the illustrations. The earliest accounts of rice gathering (1689) mention tying the heads but make it clear that much of the rice harvested was not tied but merely bent over the edge of the canoe, as shown in the drawing by Eastman. When a canoe was filled, it returned to camp, where the load was spread upon drying-frames.

The grains had then to be hulled by treading or beating. According to tribal custom, there were varying stages in these processes, since the drying frames might be smoked, the grains parched in a kettle, etc. The wild rice you purchase from your grocer has a smoky flavor if prepared in the Indian way.

Note that the main procedures in preparing wild rice closely parallel those for cultivated rice in the Old World. The two important differences are that in Asia rice is not tied in bunches to protect it from birds as was wild rice in America, and it is not smoked. On the other hand the American grain is not polished. In both areas the laborious processes are harvesting, hulling, and winnowing the grain. Like the Asiatics, the Indians almost never ground their rice but ate it boiled, usually with meat of some sort and frequently sweetened liberally with maple sugar. The Indians did not plant and weed their crops, but the labor of making twine and tying their rice was by no means a light task. Gathering the basswood bark and preparing the twine by hand occupied the spare time of the family during the winter months. We have estimated that from two to six miles of twine were needed by each family, the number of bunches tied ranging from 400 to 1600.

A world view of man's plant foods

The plant foods of man are embraced under a few main classes, as (A) cereals, (B) root crops, (C) fruits, and (D) vegetables. The cereals, or grains, head the list: wheat, barley, rice, rye, oats, the millets, and maize. All are the seeds of grasses. It appears that the period during which man merely gathered the wild foods that nature offered at the time and place, without cultivating the plants, was by far the longest span of time in human existence. During this long primitive period man overran all the habitable parts of the earth and met up with almost every variety and species of seed-bearing plants. The opportunity for experiment was almost boundless. In turn, the habitats of these grasses were spotty and highly localized. By trial and error, man probably came to recognize the most important species of seed-bearing plants in his habitat and sought to devise more and more convenient ways of gathering, processing, and cooking them.

Even from the first he seems to have been a *gourmet,* putting himself to a bewildering routine of trouble and toil to improve the raw products offered by nature. His fellow creatures were content to take seeds as they found them, but not he, as in the words of the most ancient of sages, "He prefers to earn his bread by the sweat of his brow." Even the way of the savage is the hard way. Hours and hours of patient toil are given to the preparation of what is eaten in a few minutes.

Fortunately for us, not all peoples of the earth became civilized at once. The understanding of our subject is made possible by comparing the ways of the nonagricultural peoples with the civilized. Thus in the United States we can still observe Indians gathering seeds as they did centuries ago, particularly in the semidesert lands of Arizona, Utah, Nevada, and southern California. The Paiute tribes, armed with simple ingenious basketry devices, strip seeds from many species of wild grasses, winnow out the chaff, and store the tiny seeds for grinding into meal and eventually baking in cakes, or more frequently for thickening soups. Seeds of more than 50 species were gathered by the Paiutes alone, which about exhaust the list of local wild grasses. Civilized men and women will not bother themselves over such small returns for the labor involved.

In a large part of semiarid Australia, where there is sparse vegetation and grasses, it is not surprising that the natives recognize the food value of even the smallest seeds. They carefully gather and conserve them, grinding them between stones and making cakes with the meal. It should not be overlooked that arid lands also bear numerous root plants whose bulbs are dug out with digging sticks. This is true in Australia as well as in the habitat of the Paiute Indians. Thus the popular contemptuous name "Digger Indians" is said to have been applied to many tribes west of the Rocky Mountains because they were so often seen digging in the ground for food. Some Australian explorers have written that the ground around a native encampment was so upturned as to suggest that a drove of pigs had been rooting up the place. Even Captain Lewis (of the Lewis and Clark Expedition) found the Nez Percé Indian women who were camped along the Columbia River so busy pounding roots that the noise reminded him of a nail factory.

But we are now concerned with cereals or seed grasses. We have reason to suspect that a long period of experimentation with wild seeds was necessary before success was achieved in producing the world's three great staple foods — bread, (wheat, barley, and rye), hominy (maize, hulled by boiling in wood ashes), and a bowl of boiled rice. Partly because of the large role that grasses have played in providing food for man, the semiarid lands are more often thought of as the place where agriculture began. Many root crops seem to stem from forest flora, but not all of them do. Tree-crops are chiefly of forest origin, but man probably planted grains before he planted anything so slow-growing as a tree. Plants of aquatic origin, including rice, tend to have forest homelands, but grains of the millet-wheat group seem to have been native to uplands tending toward aridity. Further, their cultivation appears to have been more ancient than rice. It is therefore most probable that the cereals and civilization developed in favorable spots in a semiarid environment and that the development of rice was stimulated by the successful exploitation of wheat. These assumptions are at least consistent with the locations of the earliest known civilized towns of any size. Civilizations are not conceivable without relatively dense populations, which in turn depend upon agriculture.

The archaeology of agriculture

The archaeology of plant foods, wild and domesticated, is only beginning to unfold, but the world is awakening to its importance and there is promise of new knowledge, like the

➤ CHIPPEWA INDIAN in boat, tying wild rice. To protect the rice from birds and wind, the Indians laboriously tied the heads in bunches. Ducks of every variety, geese, and birds of all sizes and kinds found millions of acres covered with this pleasant food, while the Indians could gather but a small quantity, according to Mrs. Eastman, who described the aboriginal scene in 1853

Courtesy of the Bureau of American Ethnology

➤ A NARROW BED of wild rice tied in bunches or sheaves

➤ THE BINDING TWINE was threaded through rings attached to the jacket the woman wore when tying wild rice. From two to six miles of twine are estimated to have been needed by each family for tying one season's wild rice. Customarily the twine was made by shredding out long slender ribbons of basswood bark fiber and tying them together (From the Chippewa Indians)

Photos courtesy of the Bureau of American Ethnology

▼ WHEN THE WILD RICE was ripe for harvest, the grain was beaten into canoes as shown in this drawing by General Seth Eastman, dating from the middle of the last century. To quote from Mrs. Eastman, the girls from an Indian village made quite a frolic of it

Eastman's Aboriginal Portfolio

◀ THE PROCESSING OF WILD RICE in America was in many ways similar to that of cultivated rice in the Orient. Here we see a Chippewa Indian treading rice in the familiar manner to remove the husks, but with two railings to take some of the weight off his feet

Courtesy of the Bureau of American Ethnology

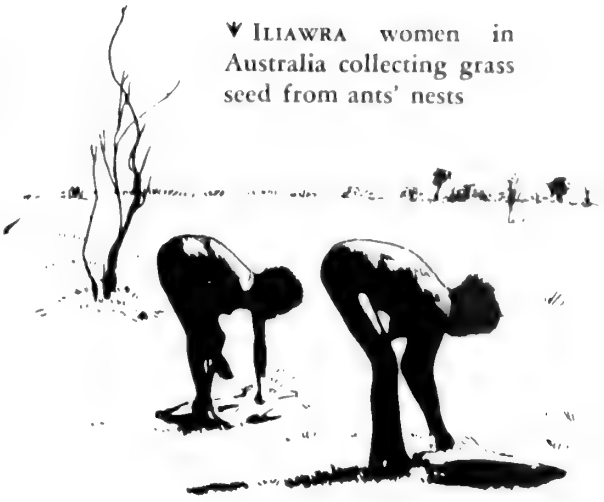
▼ WILD RICE from the country of the Ojibway Indians: above, threshed but not hulled; below, hulled and ready for storing or cooking

A.M.N.H. photo

twilight before a glorious dawn. Within another decade or two those who survive us will write a thrilling account of this new chapter in the science of man. Even now scraps of information are worth citing. We recall one of the latest contributions to the knowledge of plant foods of early man. Most of you have heard of that famous cave in China in which were found the remains of Peking Man. Embedded in the debris of that cave were masses of cracked shells of seeds which botanists have identified as hackberry (genus *Celtis*). A modern form, *Celtis occidentalis* var. *crassifolia,* still grows in western United States, especially in semiarid districts. Similar hackberry seeds are found in deposits of the Pleistocene or Ice Age in South Dakota and in north China. The mere presence of the cracked seed shells in the cave does not prove that they were eaten by man. Rodents could have carried them into the cave. However, Ralph W. Chaney of the University of California sought to solve this problem in a scientific way. He offered modern hackberry seeds to rodents and monkeys of several different species. Most of the rodents ignored them, but the few that ate them merely gnawed small holes into the shells to extract the kernels, whereas the shells in Pekin Man's cave were crushed to fragments. The monkeys chewed the seeds and spat out the shell fragments, which were similar to those in the cave, but there is no archaeological evidence that monkeys lived in the vicinity of the cave when Peking Man was there. Since even modern Indians in western United States eat hackberry seeds, Professor Chaney gathered information from them. He found that their method was to crush the seeds between stones to secure the kernels and that the resemblance of these fragments to those from the cave approached identity. We do not know whether Peking Man chewed the seeds or crushed them between stones, but since he used simple stone tools, it seems fair to assume that he gathered hackberry seeds and carried them home to crack at his leisure.

Diggings by archaeologists almost everywhere have brought to light the charred remains of grasses and seeds, and botanists have usually been able to identify them. In the previous articles on wheat and maize we have mentioned such findings. In the submerged remains of Swiss lake dwell-

➤ ALL of the world's modern production of wheat, corn, and rice has grown out of the primitive occupation of collecting grass seed. Today we can still see this elementary activity among the naked, hungry Australian "blacks," as shown in these drawings. For thousands of years, primitive women have thus gathered food—a seed or two here, another there—at great cost in toil and patience and with a return so trifling as to transcend belief



▼ ILIAWRA women in Australia collecting grass seed from ants' nests

▼ TREADING the grass seed to husk it

WINNOWING the husked grass seed

Drawings by Paula Hutchison, from photographs

THE SIMPLE but exacting routine of converting grass seeds to food is everywhere the same: (A) find the ripening seed, (B) strip the grain from the stem, (C) hull it by treading, (D) winnow out the chaff, (E) pulverize the seeds, (F) combine with water to form a paste, (G) bake or toast on a fire

ings were found charred and natural remains of many cultivated plants, including wheat, barley, rye, oats, millet, celtic peas, and carrots. By such finds it has been possible to distinguish between the horizons of agricultural and nonagricultural peoples.

In the New World we now find special published articles on the prehistory of cotton, beans, peanuts, sunflower seeds, gourds and squashes, tobacco, maize, etc., each a fascinating chapter in the unwritten history of the world. One conclusion to be drawn from such data for the United States is that other kinds of agriculture were practiced in Kentucky, Tennessee, Missouri, and Arkansas long before maize was introduced into that region. In fact, the last crops to appear were maize and tobacco. Long before they were grown, sunflowers, squashes, gourds, and seed plants were a part of the agricultural economy of the tribes. A recent publication by George F. Carter* tells how the new data resulting from preserved seeds and fragments of the *Cucurbita* (gourds, squash, pumpkin, etc.) suggest that their cultivation in southeastern United States long preceded maize in the same area and that they found their way in pre-maize times into New Mexico and Arizona. In general, this new information fully justifies the belief that agriculture in the New World was developed independently and without influence from the Old.

Our younger readers can look forward confidently to the time when a much more complete story of man's achievements with plant foods can be written.

**Plant Geography and Culture History in the American Southwest,* Viking Press, 1945.

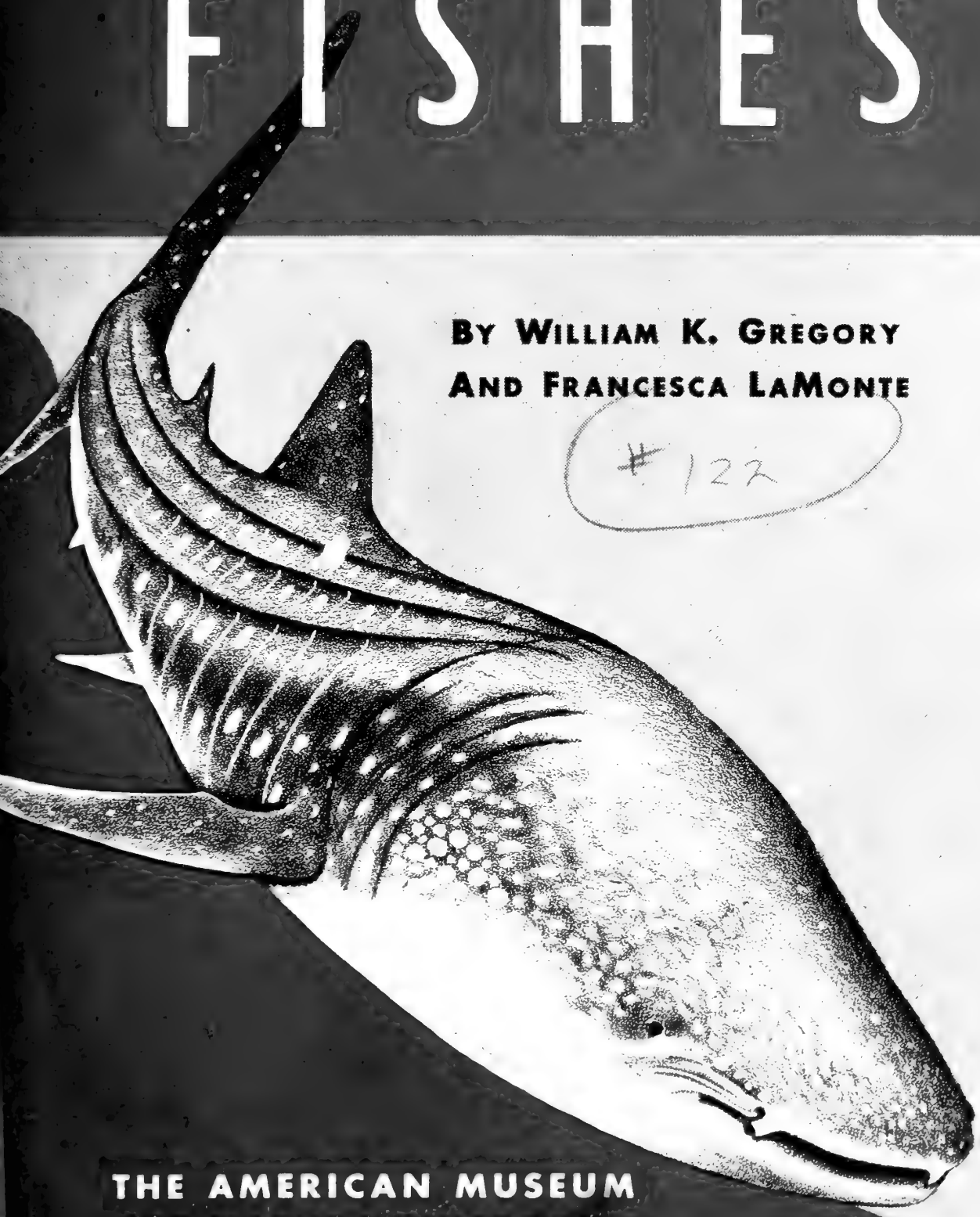
▼ A SEED-GATHERING BASKET AND BEATER from the Paiute Indians of Nevada. The basket is shaped so that the edge can be held low and the grass stalks bent over it and shaken by the beater. Again, the beater may be used to catch falling seeds and transfer them to the basket

A.M.N.H. photo

The World of FISHES

By William K. Gregory
And Francesca LaMonte

#122



THE AMERICAN MUSEUM
OF NATURAL HISTORY

The World of Fishes

The world of FISHES

A SURVEY OF THEIR HABITS, RELATIONSHIPS, AND HISTORY, AND A GUIDE TO THE FISH COLLECTIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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Fisherman in the native market on the beach at Cabo Blanco, Peru

Photograph by Michael Lerner Chile-Peru Expedition, American Museum of Natural History, 1940

Introduction

←Remora, the Shipholder: a small fish for centuries believed capable of stopping ships in their courses. (After Camerarius, 1654)

FISH STORIES have been told by romancers of all ages, and a public that loves to be humbugged has greedily believed them. Ancient, and equally astonishing, are the tales of the mermaid, the sea-serpent, and the giant Devilfish that threw its slimy tentacles around a Chinese junk. The myth of the Shipholder lasted from Aristotle's time to the end of the Middle Ages, and prominent roles in ancient naval encounters were assigned to this small fish which, by means of the adhesive disc on top of its head, was said to "bridle the impetuous violence of the deep" and stop large vessels in their course.

But man's puny imaginative efforts are put to shame by nature's own inventions. There is in reality a deep-sea Anglerfish in which the female is a thousand times heavier than the male who hangs like a pendant from the cheek of his huge mate. There are "four-eyed" fish equipped for vision both above and below the water line; fishes fully furnished by nature with rod, line, hooks, and angling bait; fishes carrying high voltage electrical equipment; fishes that hop about on land, and fishes that drown without atmospheric air!

All these oddities are included in the exhibits in the American Museum of Natural History. The main object of the exhibits, however, is not to place emphasis on the

Courtesy N. Y. Zoological Society

←The Four-eyed Fish (*Anableps anableps*), which is equipped to see above and below water at the same time

peculiar, but to show fish life in its most typical phases. In the Hall of Fishes of the World, there is a representation of the more important families to which the 20,000 known species of fish belong. They are classified and arranged according to their natural relationships with one another, and a number are exhibited in settings showing their natural habitat and life history, their commercial use, and their value to the angler.

The Bashford Dean Exhibit of Fossil Fishes is concerned with fishes of past ages, including some of the ancestral forms from which the fishes of the present time have descended.

We have frequent requests for "a book dealing with every known kind of fish in the world," but there is not and probably never can be such a work, although there are hundreds of books and papers dealing with fishes of particular countries and regions and with the many wonders of fish life. A short list of books cannot be inclusive, but the few references given at the end of this book may be found helpful.

One of the Oceanic Anglers, *Linophryne*, with luminous "headlight" for attracting its prey

A.M.N.H. photograph

The Biology of Fishes

Spawning

Fishes reproduce themselves by the union of two germ cells, one from the female, the other from the male parent. The female germ cell is the egg, or *ovum;* the male germ cell is the sperm, or *spermatozoon.* The two parent cells unite to form a single cell which is the fertilized egg, or *zygote.*

The egg is fertilized by the male element, which starts the process of development. But the male cell does much more than this; it brings with it all the hereditary tendencies derived through the father. The egg carries the hereditary tendencies derived through the mother.

INTERNAL FERTILIZATION: In some of the sharks, and in a few of the bony fishes, fertilization of the female's egg by the male sperm takes place within the body of the female fish after mating. The egg develops inside the female's body, and young fish are born.

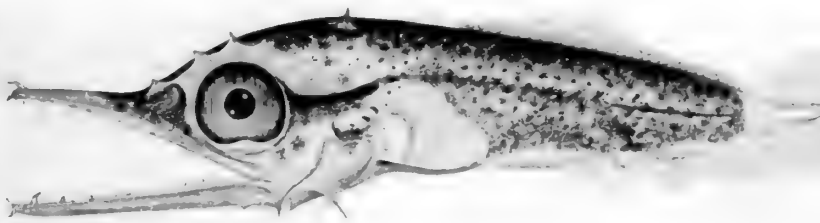
In some other fishes there is internal fertilization, but the eggs are deposited in the water as eggs, and develop and hatch there.

EXTERNAL FERTILIZATION: In most of the higher fishes there is no introduction of sperm into the body of the female fish. In the mating act the eggs and sperm are simultaneously discharged into the water, and there the eggs develop and the larval fishes are hatched.

TYPES OF EGGS AND OF DEVELOPMENT: The eggs of sharks and rays are large and contain a large quantity of yolk. They are few in number and are normally covered with a horny shell secreted by the walls of the egg duct. In oviparous, or egg-laying, sharks, such as the European Dogfish, these eggs are laid, and the young, after a long time, hatch out from them. In many other sharks, however, where the young are long retained within the enlarged egg duct, the egg shell is either broken down or absorbed within the female parent's body, and the

➔ Larval Swordfish 2½ inches long, taken in the Straits of Messina

From Sanzo, 1930



➘ Adult Swordfish weighing 601 pounds, caught off Louisburg, Cape Breton Island, Nova Scotia

A.M.N.H. photograph

young are born in an advanced stage of development rather closely resembling their parents in general appearance and in feeding habits.

The opposite extreme is the method seen in most bony fishes, in which the eggs are very small and great numbers of them are deposited. After fertilization of the egg, the development of the embryo begins, and the fish finally reaches a free-living larval stage. This stage differs markedly from the parent fish in its small size, general appearance, and feeding habits.

The actual development within the egg shows marked differences from one group of fishes to another. One type of development is illustrated in the chart opposite, which pictures some of the successive stages in the development of the Australian Lungfish, *Epiceratodus forsteri.*

The first stage shows the fertilized egg, which is about one-eighth inch in diameter. The lower part of the egg is filled with yolk. In the next stage the egg has divided into halves. In the succeeding stages this process of subdivision continues until many millions of cells result. The general outline of the embryo is beginning to be visible in number 7; the head is at the left. In number 10, we note the already swollen brain. The heart, muscle segments of the body, and the segments of the spinal column are also indicated. The young fish is shown in number 13. Number 14 represents the adult.

A.M.N.H. photograph

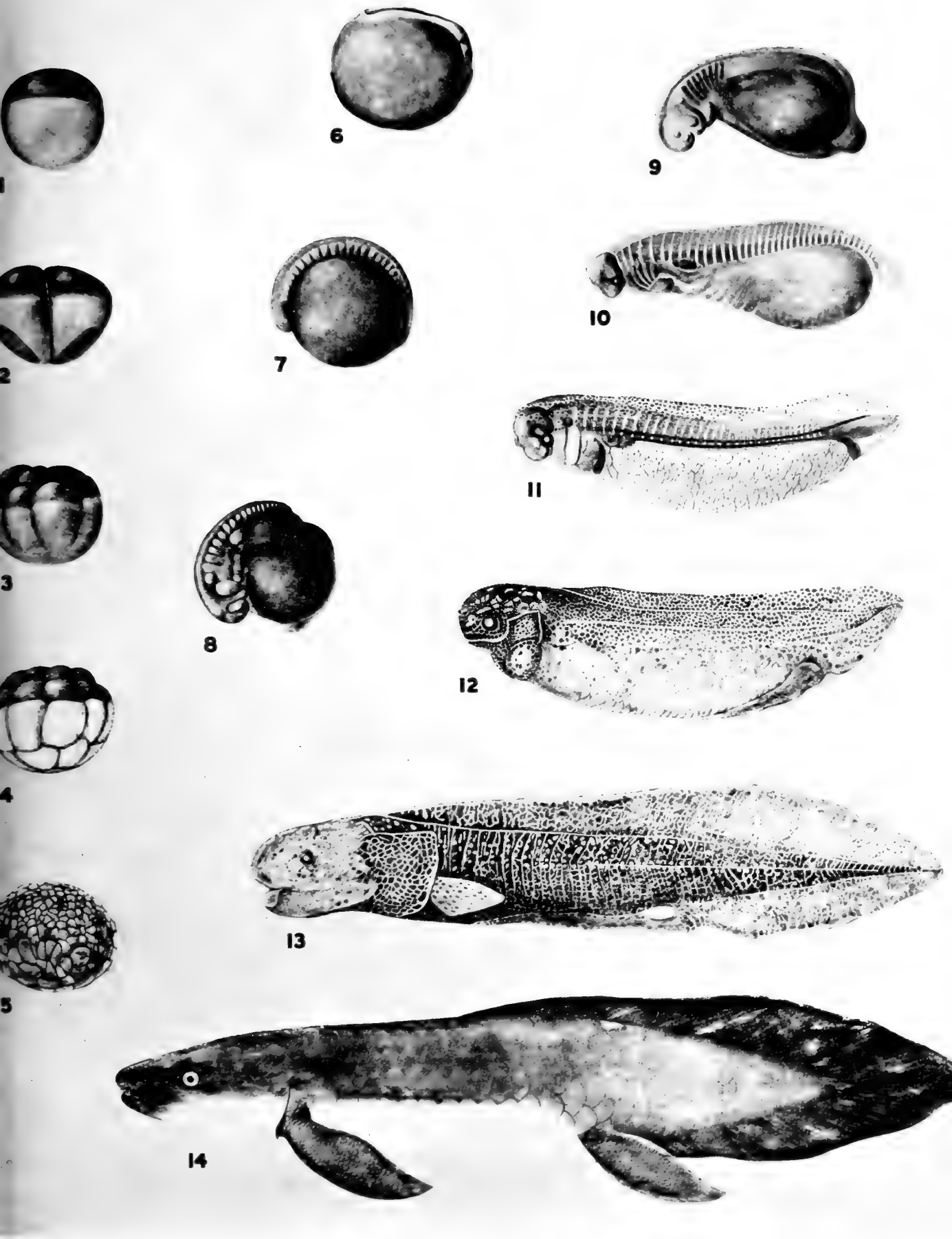
Eggs discharged into the water may either float or sink; the former are known as pelagic eggs and the latter as demersal eggs. No pelagic egg is very large, and they are often less than a millimeter (one-twenty-fifth inch) in diameter. They are transparent and often contain a large globule of oil. Such eggs are produced in countless numbers by fishes of many families—cods, flounders, mackerels, etc.

Some of the demersal eggs reach a larger size. Those of the salmon, for example, are about 5 millimeters (three-sixteenth inch) in diameter. In many demersal eggs the outer egg membrane is viscid and adhesive, so that the eggs readily stick to one another or to rocks, stones, or bits of seaweed.

Parental Care

In many cases among the bony fishes one or both parents, instead of abandoning their progeny to be the sport of the elements and the prey of innumerable enemies, either construct a nest, as in the case of the Bowfins and the Sticklebacks, or in some other way guard and protect the young. The eggs may be deposited in some secure retreat, as in old oyster shells. Among the Sea Horses, the males receive the eggs in a brood pouch of skin beneath the abdomen, where they undergo their development. In the Cichlids and certain catfishes, one or the other parent takes the eggs in its mouth and does not eat again until the young are large enough to be released safely. In such cases, the number of eggs produced at one time may be small, since the parental care greatly improves the chances of survival for the offspring, while the individual eggs may be large.

← Eggs of the Gunnel, *Pholis*, deposited in an oyster shell and guarded by the parent fish (From a model in the Hall of Fishes of the World)



A.M.N.H. photograph. From wall painting by W. Beneker, after Semon

Development of the Australian Lungfish (*Epiceratodus*) from egg to adult

The Economic Pyramid of Fish-Eat-Fish

(From J. T. Nichols: "Remarks on Size in Fishes," *Marine Life,* 1944, vol. 1, no. 2, page 5.)

"One aquatic species preys upon another in a chain expanding downward from the predaceous monsters of the deep to the microscopic diatom. The diatoms are plants and can subsist on inorganic matter plus sunlight. Looking at it the other way around, the diatoms are so abundant that they support the whole great pyramid of sea life with the largest predators at the top. It will be seen at once that the nearer the base of the pyramid, the more abundant the potential food supply. By reaching several steps downward to the diatoms themselves, the menhaden nourishes its swarms, which persist due to their very bulk. There is analogy between the case of the menhaden and that of the very largest fishes, basking shark (*Cetorhinus*) and whale shark (*Rhineodon*). These are not predaceous, but strain rather small creatures from the water with their meshwork of highly developed gill rakers, and are thus able to support an individual bulk which renders them immune from attack.

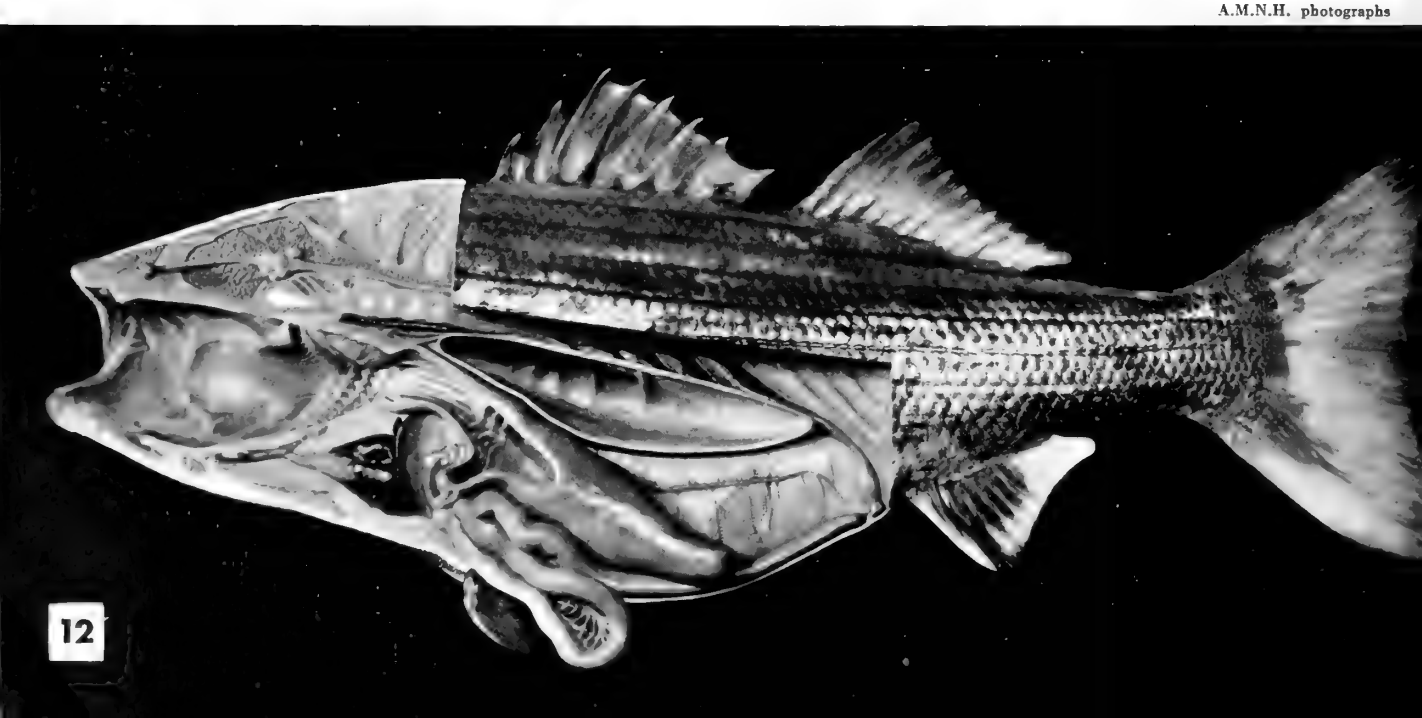
"It is logical enough that as the predators grow larger and larger, at higher and higher levels in the pyramid, they must grow fewer and fewer, and that this places a limit on their size. . . ."

Locomotion of Fishes

ENGINES OF THE FISH'S BODY: As a living, self-directing machine, the fish needs all the complex apparatus shown in the accompanying illustrations. Its jaws, mouth, and digestive system capture and prepare its fuel. Its heart and circulatory system (below) distribute the fuel to its engines and propellers, the muscles and fins, (opposite). By means of the oxygen absorbed by its gills from the water, it consumes the fuel and releases the necessary energy, which is expended in driving the body forward and is lost in the form of heat.

Engines of the Fish's Body: a model of a Striped Bass (*Roccus saxatilis*). Here are seen the organ systems for the capture and utilization of foods and fuel, and those for control and direction

A.M.N.H. photographs



Millions of delicate sense organs—tactile nerve endings, taste buds, lateral line organs, etc.—are constantly recording the changes in the surrounding medium and in the position of the various parts of the body, while the nose, eyes, internal ears, brain, and spinal nerve cord also act as an automatic control or steering system. The fish's framework, the skeleton, consists of a system of jointed levers and supports.

The greater part of the body of the normal fish is occupied by the locomotor machinery. This, in brief, consists of a close-set series of zigzag muscle segments running along the sides of the body from the head to the tail, making undulation possible. The fins act as keels, rudders, and brakes, and partly as paddles.

TYPES OF LOCOMOTION:[1] The Eel and the Trunkfish illustrate two extremely different methods of locomotion. The Eel has many joints in its backbone and just as many zigzag muscle segments on the sides of the body. By means of these, the Eel throws its long, slender body into a series of small waves, which pass backward faster than the fish moves forward. The Trunkfish, on the other hand, has a rigid body which swings from side to side with a sculling movement of its flexible tail.

Almost exactly between these two extremes stands the type of motion illustrated in such fishes as the Crevalle, or Horse Mackerel (*Caranx*). The fish's body is short, but not rigid. The movement is essentially the same as in the Eel, except that only one large curve can be formed at a time.

These superficially very different modes of locomotion are actually all based on the same dynamic principles, and the driving muscular action is relatively the same.

STREAMLINE BODY FORMS: Ships, submarines, torpedoes, airplanes, etc., are designed and built with "streamline" bodies so that they can slip through water or air with the least resistance. The typical fish body has streamline contours. The proportions of the body, however, vary enormously in different fishes, that is, the length in

[1] For a detailed article, see C. M. Breder, Jr.: "The Locomotion of Fishes," *Zoologica* (New York Zool. Soc.), 1926, vol. 4, no.5, pages 159-297.

This model shows the muscular system which generates and supplies locomotion, and the jointed skeleton which supports the muscles

relation to the height and the width, and the relative size of any single part such as the jaw or any one of the fins. Between any two extremely unlike body forms there are many intermediates.

Amphioxus, a Stem Chordate

The Lancelets are small, fishlike creatures from 1½ to 3 inches in length. They live mostly in the tidal zones of the warmer seas. They swim quickly and dart into the sand, drawing in water through the mouth, and extracting from it microscopic food particles.

Their anatomical structure is greatly simplified as compared with that of typical vertebrate animals, and they have generally been regarded as the most primitive of all known chordates.

The anatomy of *Branchiostoma,* one of the *Amphioxus* group, is shown in the photograph opposite depicting two of the remarkably accurate and beautiful models made by Dr. G. H. Childs which are exhibited in the American Museum.

The ground plan of the anatomy includes three parallel tubes, one beneath the other. The upper, or dorsal, tube is the nerve cord; the middle one is the notochord or central axis; the lower tube is the gut, or digestive tract. In the middle part of the body on either side of these tubes are rows of contractile muscle segments. In front, the gut connects with the greatly expanded pharynx, or gill chamber, including a great number of gill-bars, bearing blood vessels.

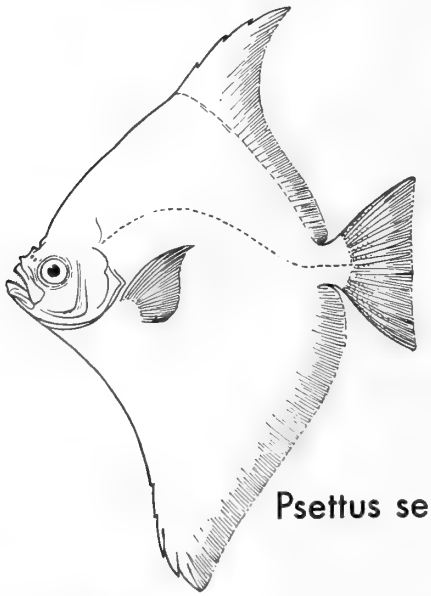
The name "Amphioxus," meaning pointed at both ends, was given because the notochord is continued forward to the front tip of the body. There is reason to believe that the extreme simplicity of the brain and total absence of a brain case may be the result of degeneration. The excretory organs are of an exceedingly simple type and consist of separate "nephridia," not combined into a kidney.

The right and left sides of the animal are not quite symmetrical, due to the crowding of the embryonic branchial pouches.

On each side, longitudinal folds of the body grow downward and meet below, forming an atrial chamber which encloses the branchial openings and has complex relations with the coelom or peritoneal space.

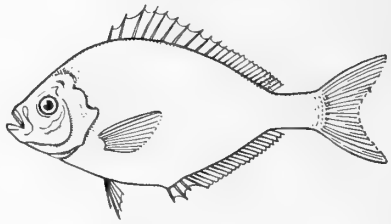
Two extremes of body form —very long and very high— and a primitive intermediate

From W. K. Gregory



Psettus sebae

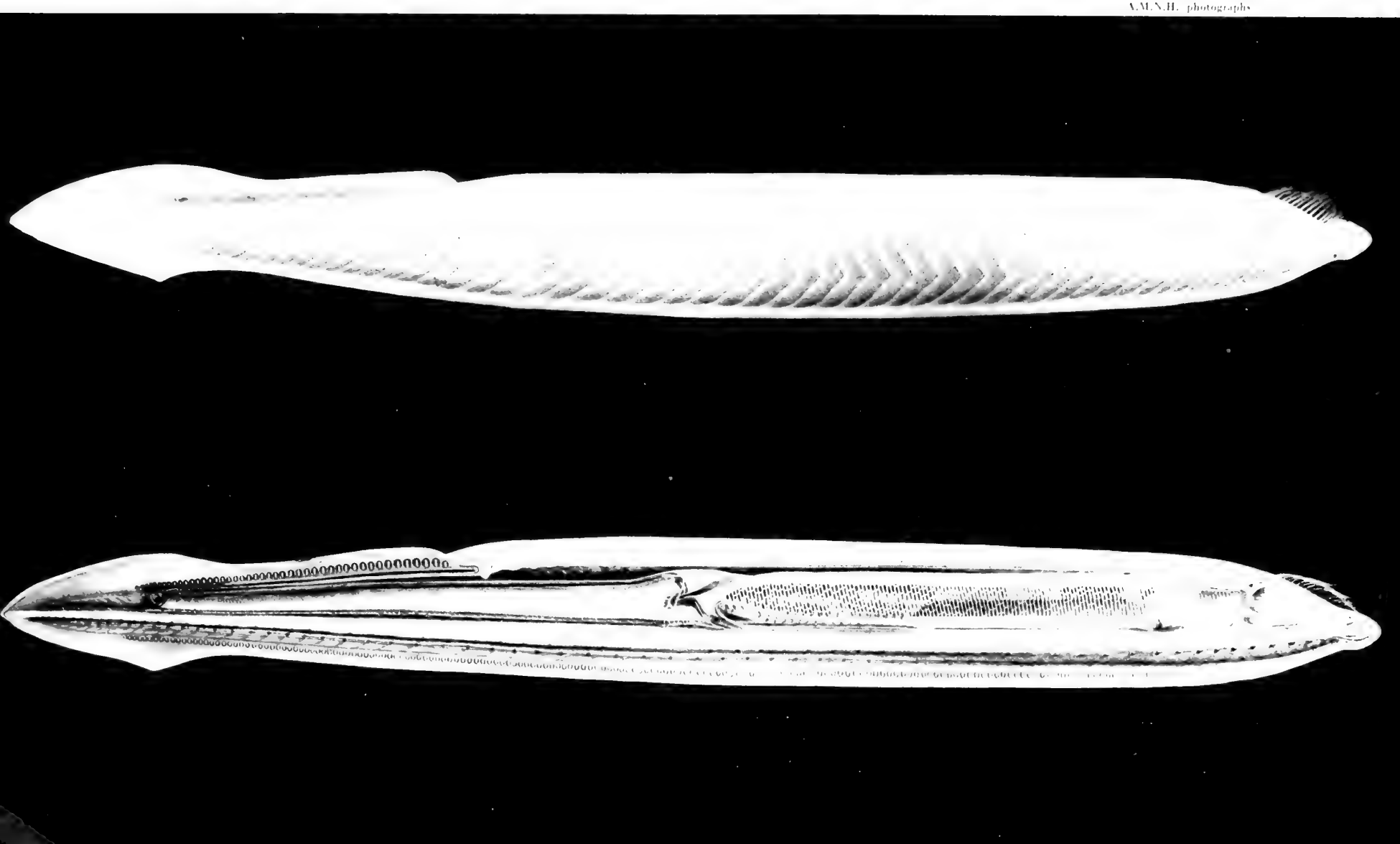
Scorpis lineolatus



Ptilichthys

Among living animals, the Lancelets represent the earliest relatives of the fishes. These enlarged models show the internal anatomy and the musculature of *Branchiostoma,* a member of this group

A.M.N.H. photographs



Archaic Fishes

(Lampreys, Sharks, Rays, Lungfishes)

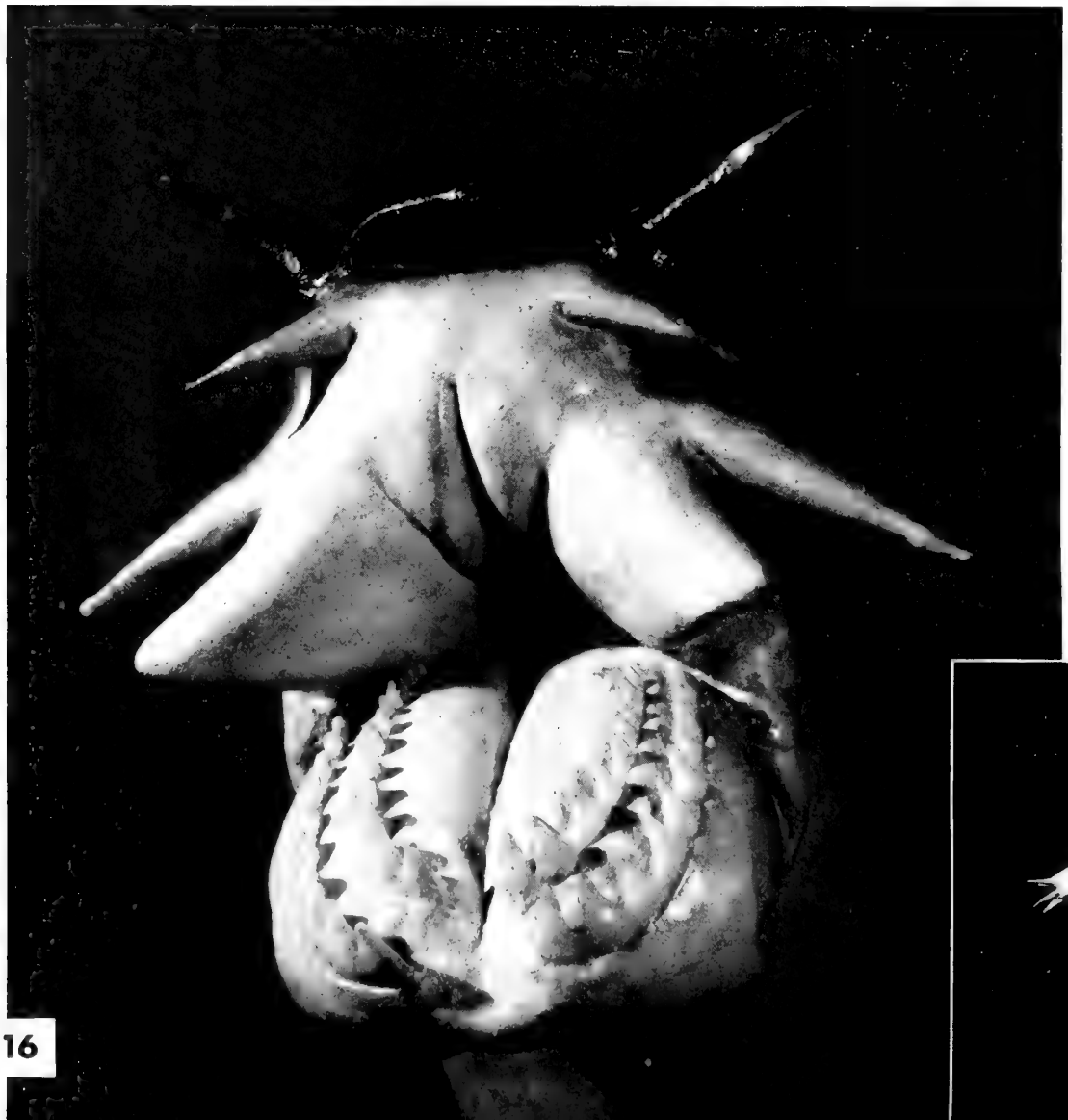
Lampreys and Hags

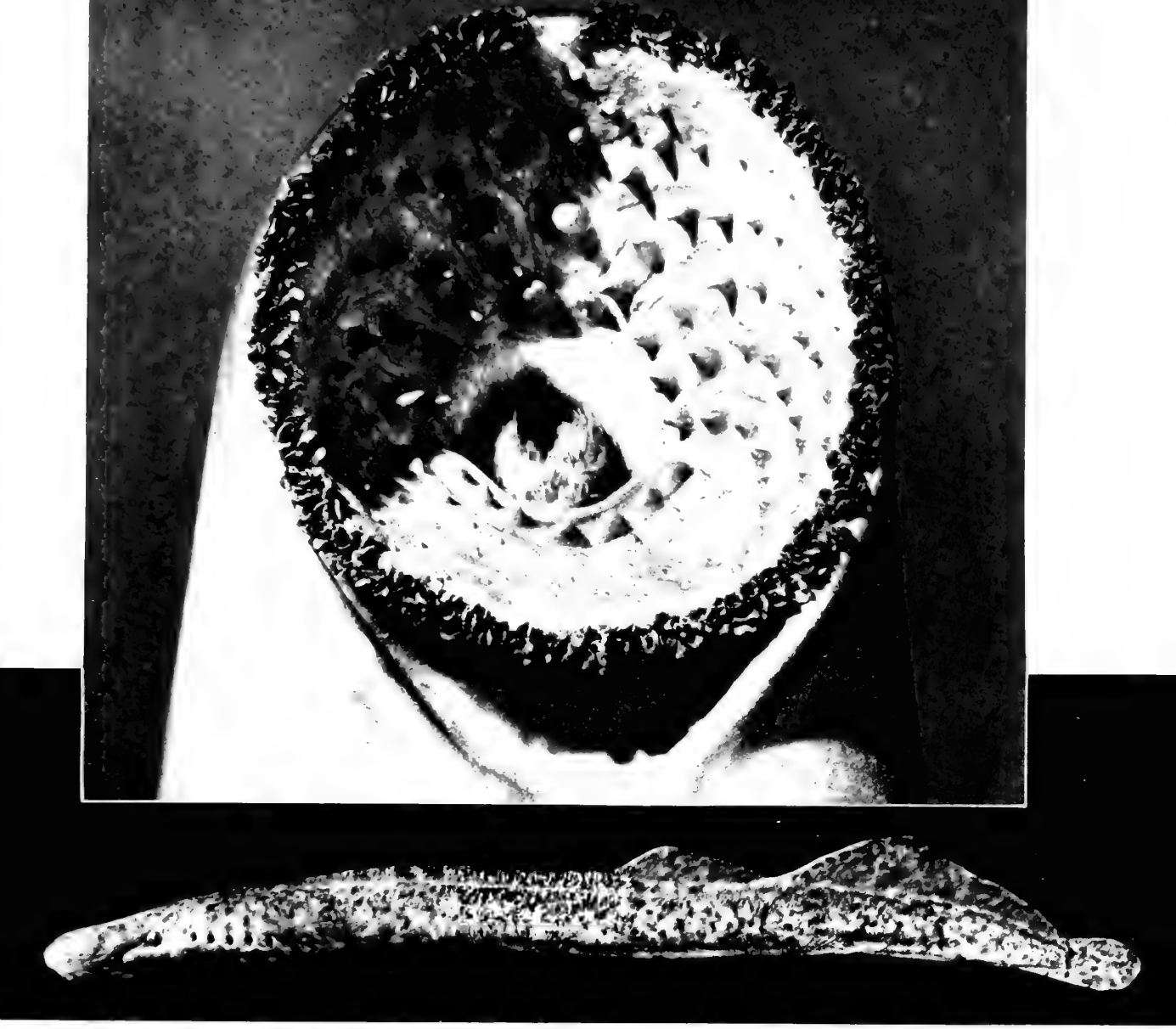
(CYCLOSTOMES)

This class, the Cyclostomata, includes the two groups of fishes known as the Hags and the Lampreys, eel-like forms with round, jawless, sucking mouths and rasping tongues. With these weapons, they fasten themselves on larger fishes and feed upon them. From the numerous mucous pits along the sides of the body, they secrete a gelatinous substance which swells into a jelly on contact with the water.

These creatures appear to be the highly modified and degraded descendants of the Ostracoderms, the oldest known forerunners of the backboned animals, but the intervening stages are missing from the record.

The Sea Lamprey comes from the sea into fresh water to spawn. As is shown in a group in the American Museum's Hall of Fishes, it roots up and pushes about the pebbles of clear, shallow streams in order to make a nest in which the eggs may be deposited and fertilized.

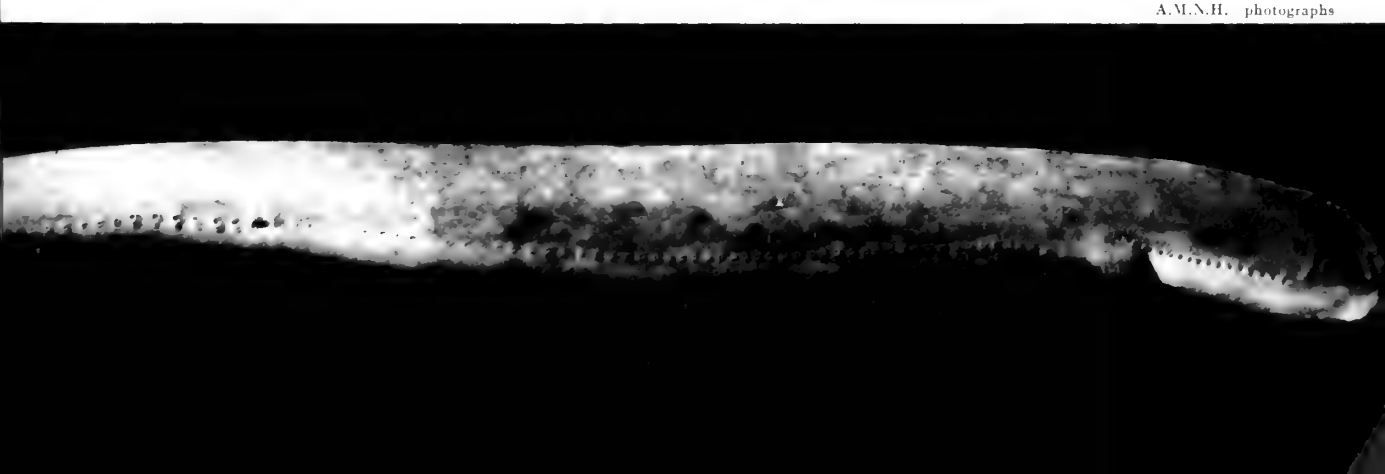




← A vampire of the sea with illustrious lineage. The modern hagfish is a "die-hard" that has retained many primitive features and survives today as a veritable living fossil. It lacks the true jaws of modern fishes, and in place of a backbone it has an elastic notochord. But it has a full kit of burglar tools for rasping a hole in the side of a fish and sucking out its blood

↑ Another living fossil is the lamprey, likewise shown in front and side views. Its efficient suction disc has permitted the lamprey to survive down to the present in spite of its refusal to adopt a modern body design. Lampreys are erroneously called eels. In the tree of life they are further from eels than eels are from man

A.M.N.H. photographs



Sharks

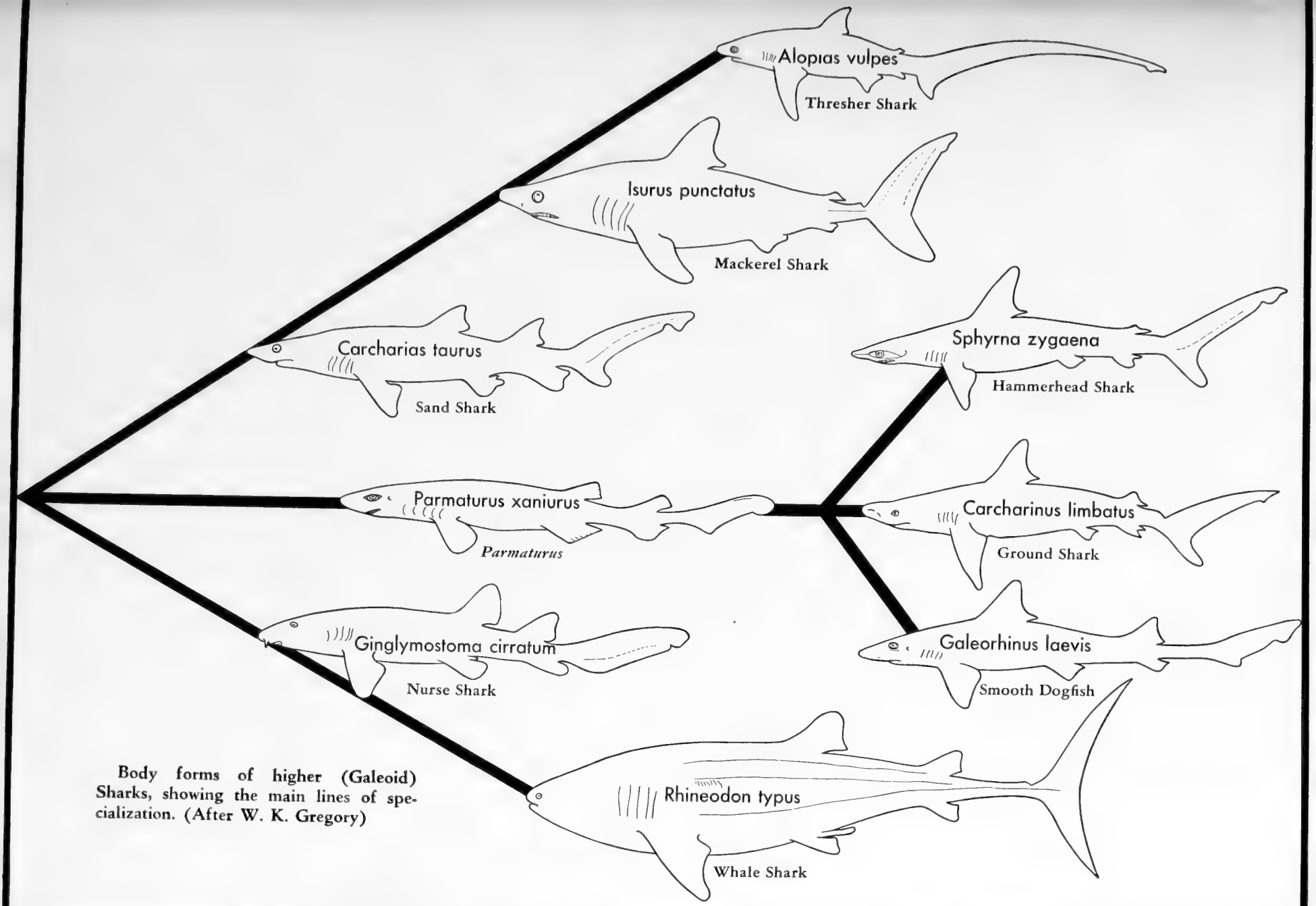
The Sharks of the present are the survivors and descendants of those that lived many millions of years ago in the Devonian age of the earth's history (see Fossil Fishes, page 85). They differ from ordinary fishes especially in the gristly or cartilaginous state of the skeleton, which is not strengthened by bony tissue but by deposits of calcium carbonate and calcium phosphate. The skeleton as a whole is in a primitive or generalized state as compared with that of higher vertebrates, and the same is true of the brain, blood vessels, digestive system, etc. Hence a study of the anatomy of the Shark forms an excellent introduction to the anatomy of the higher vertebrates, including man.

The adjacent diagram attempts to visualize the evolution of the body forms of the higher Sharks from some ancient central stock which is most nearly typified by the existing Sand Shark. Each figure stands for a family or group of related forms, and the branching of the lines indicates the relationships.

The Port Jackson Sharks (Heterodontidae): During and before that ancient period of the earth's history in which the vast swamps and forests of Pennsylvania were accumulating their stores of coal-forming vegetation, the shallow seas of the world swarmed with ancient Sharks, many of which bore curved spikes on the front margins of their fins. The more specialized forms of these early Sharks became extinct, but one family survives—the Port Jackson Sharks—and is still found living in the Pacific Ocean. These Sharks retain the stout fin-spines and whorled crushing teeth of their vastly distant ancestors. They lay eggs that are enclosed in a spirally twisted egg case.

The Sea Rovers: an undersea scene showing sharks attacking a Sea Turtle. In the lead is a 12-foot Tiger Shark. On the left is a Hammerhead, and in the background, the White, or Man-eater Shark

From F. L. Jaques' painting of a group in the American Museum. A.M.N.H. photograph

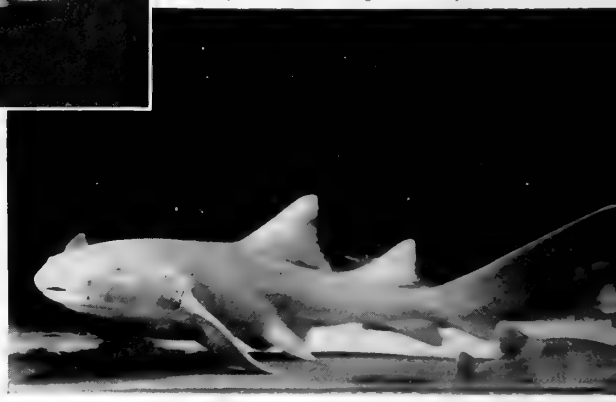


Body forms of higher (Galeoid) Sharks, showing the main lines of specialization. (After W. K. Gregory)

←Sand Shark (*Carcharias littoralis*) in the New York Aquarium

↓Nurse Shark (*Ginglymostoma*) in the New York Aquarium

Courtesy of N. Y. Zoological Society



The Spiny Dogfishes or Squaloid Sharks (Squalidae): These are far removed from the higher Sharks and appear to be related to the ancestral stock of the Rays. They have lost the anal fin. Their teeth are usually closely packed and more or less uniform. Some of the deep-sea members of the family are only a few inches long, while the Greenland Shark is said to reach a length of 24 feet. In the common Spiny Dogfish, the eggs are surrounded by a horny shell, which breaks down within the egg duct. The young are born in an advanced stage of development.

The Japanese Sawsharks (Pristiophoridae): In both the Sawfishes (Pristidae) and the Sawsharks, the nose is produced into a very long, flat rostrum, armed on each side with a row of teeth. In the Sawfish, these teeth are stout and strong and the fish has been known to reach a length of well over 14 feet and a weight of over 700 pounds. The Sawshark, on the other hand, is a smaller fish with much smaller, sharper teeth, a smaller tooth alternating with each large tooth. A comparative study of the skeleton and internal anatomy of these fishes shows that the Japanese Sawshark is more nearly related to the spiny-finned sharks, while the true Sawfish is closely related to the Guitarfishes. In other words, the saw-toothed rostrum has been acquired independently in two distantly related groups.

The Notidanoid Group: This group includes the long-bodied deep-sea Frilled Shark (*Chlamydoselache*), the Cow Sharks, and their allies. These have only one dorsal fin, and not less than six large gill clefts. The Frilled Shark has trident-shaped teeth, but in the Cow Sharks and their allies the lower teeth are sawlike. They lay eggs with very large yolks.

The True Dogfishes and Cat Sharks: These widely distributed Sharks are variously called Scylliidae, Scylliorhinidae, and Catulidae. As in all the higher Sharks, there are two dorsal fins without spines. These fins are displaced backward, and the lower lobe of the caudal fin is not much produced. Their teeth are many-pointed. The egg cases are elongate and quadrangular, with their corners produced into long curling filaments. This family dates from the Jurassic period. The common Smooth Dogfish

(*Mustelus*) does not belong to this family, but is related to the Requiem Shark group (see page 23).

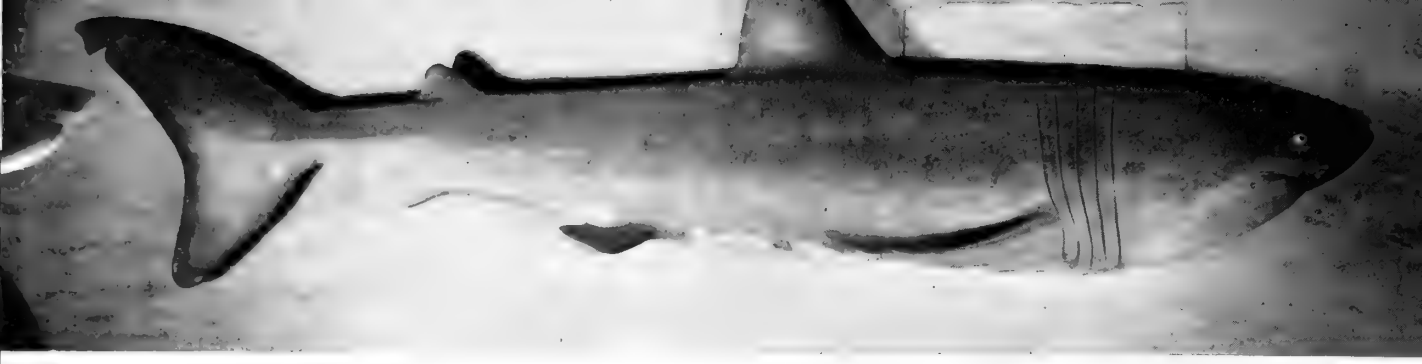
THE SAND SHARKS (Odontaspidae, Carchariidae): These are perhaps the most central or generalized of the higher Sharks. The body is perfectly normal and none of the fins are reduced or displaced. The teeth have needle-sharp points with small accessory cusps on either side of the base. The gill slits are of ample size and lie entirely in front of the pectoral fin. The checkerlike centra of the backbone are of the asterospondylic, or star, type, with four uncalcified streaks radiating outward from the center. The family of the Sand Sharks dates from the Cretaceous. A deep-sea member of it, *Scapanorhynchus,* has an elongate, depressed snout.

THE NURSE SHARKS (Orectolobidae): The Nurse Sharks are related to the Sand Sharks but are specialized for a more sluggish life. The head is typically broad and more or less depressed. The teeth are small, closely packed and flattened. The dorsal fins are more or less displaced backward. There are one or more flaps or projections of skin around the mouth. The eggs of the Nurse Shark are about as large as goose eggs, with a delicate, horny shell. It is believed that these eggs are retained in the body during the entire incubation period and that free young are released as in the Requiem or Carcharinid Sharks. In this respect the Nurse Sharks are intermediate between the true Dogfishes (Scylliidae) which are oviparous (egg-laying), and the Requiem Sharks which are viviparous (producing living young). Fossil representatives of the Nurse Shark family date from the Eocene period, between about 35 and 60 million years ago.

THE WHALE SHARK *(Rhineodon typus):* Recent investigations indicate that the Whale Shark represents a peculiar family, possibly related to both the Nurse and the Mackerel Sharks. The Whale Shark is the largest living fish. The American Museum specimen is the mounted skin of a young Whale Shark, but the adult has been measured up to 45 feet and is estimated to reach

The world's largest fish is the Whale Shark *(Rhineodon typus),* represented here by a young specimen harpooned by local fishermen off Cabo Blanco, Peru

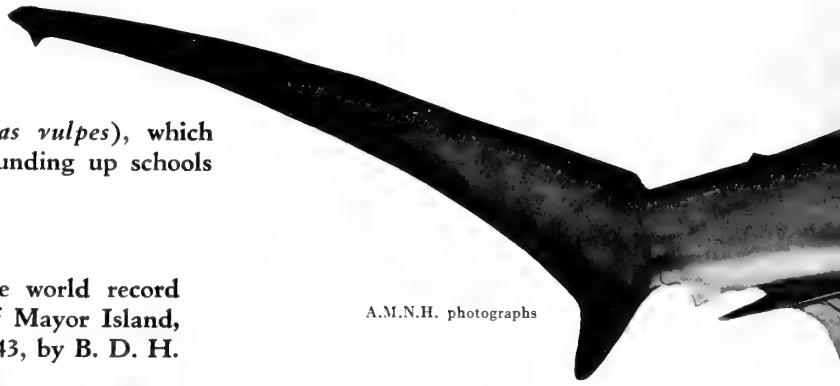
Photograph by R. Norris; courtesy International Game Fish Association



A 14-foot specimen of Basking Shark (*Cetorhinus*) on exhibit in the American Museum

60 feet. The first one of these Sharks recorded by scientists was taken in Table Bay, South Africa, in 1828, since which time they have been found to frequent all warm seas. The fish is easily recognizable because of its huge size and the black and white checkerboard markings of its body.

This Shark resembles a whale in its manner of feeding as well as size. The teeth, about 3000 in each jaw and only ⅛ inch long, are set in many rows, but are useless for biting. Despite its huge size, the Whale Shark is harmless. Its food consists of small organisms filtered out of the water by its gill rakers. It has no known enemies and puts up no fight when captured by man.



Thresher Shark (*Alopias vulpes*), which uses its enormous tail in rounding up schools of fish

A.M.N.H. photographs

A 1000-pound Mako, the world record rod and reel catch, taken off Mayor Island, New Zealand, March 14, 1943, by B. D. H. Ross

Photograph by F. Louden; Courtesy I.G.F.A.

THE BASKING SHARK (*Cetorhinus maximus*): This Shark is rather like the Whale Shark in its manner of life but is not related to it. Some ichthyologists put it in a separate family, the Cetorhinidae, although it most probably belongs with the Mackerel Sharks. It is another giant fish with very small teeth and sievelike gill rakers which strain its food from the water.

THE MACKEREL SHARKS (Isuridae): This group, which includes the Porbeagle Shark, the Mako, and the White or Man-Eater Shark, represents a swift-swimming adaptation from some ancient relative of the Sand Sharks. The upper lobe of the tail fin is turned sharply upward; its lower lobe is

produced downward so that the tail as a whole is more or less lunate, or crescent-shaped. The tail base is supported by lateral keels. The second dorsal and anal fins are much reduced.

In this family the teeth range from the simple, sharply triangular teeth of the Mako to the broad, serrate-edged triangles of the White Shark and the far larger, heavier teeth of the gigantic extinct *Carcharodon* (see page 85). The gill slits are very large and are wholly in front of the pectoral fins.

The Thresher Shark (Alopiidae): This is a heavy-bodied derivative of the Mackerel Shark group, from which it has inherited its very small second dorsal and anal fins. The enormous tail is used for rounding up the schools of fish upon which it feeds.

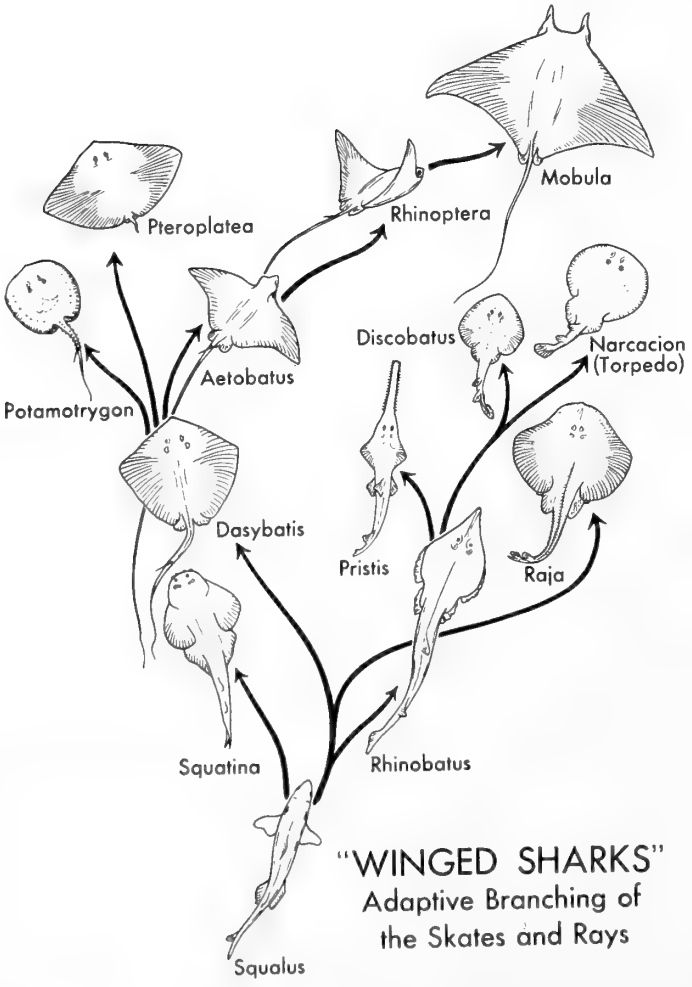
The Requiem Sharks (Carcharhinidae): These are the most numerous and dominant group of the present day. They arose later than most of the other families and their fossil teeth date back at most to the Eocene epoch. They have advanced beyond the lower Sharks (such as the true Dogfishes) by retaining the eggs within the egg tube until the young are well developed; the young are, therefore, born alive. The Requiem Sharks may be distinguished from the Sand Sharks (*Carcharias*) by the fact that the last one or two of the rather small gill slits lie above the base of the pectoral fin. The base of the tail is notched above and below, and the upper tail lobe is turned partly upward while the lower lobe is more or less produced. The Blue Shark (*Prionace*

A Blue Shark and its newly born young. They are swimming about in the Sargasso Sea, under a ship, looking for food. (From an exhibit in the American Museum)

glauca) is a long, slender fish (see illustration). The Tiger Shark may be recognized by the recurved blades of its teeth. In the New York Ground Shark (*Carcharhinus milberti*) the body is heavy and the snout massive. The Smooth Dogfish (*Mustelus*) somewhat resembles the true Dogfishes (Scylliidae), but differs from them in the more normal position of the first dorsal fin which is not displaced backward. The teeth are flattened, and the fish feeds on crabs, squid, and other marine creatures.

The strange-looking Hammerhead Shark (*Sphyrna zygaena*) appears to have evolved from some more normal member of the Requiem Shark group in which the snout was very broad. The Bonnet Shark (*Sphyrna tiburo*) shows an intermediate stage in the widening of the head. The Hammerhead is a swift swimmer and can make sharp turns with great agility, apparently using the flattened head as a rudder.

Profitable commercial fisheries for Sharks are conducted in various parts of the world. Shark skin, which is covered not by scales but by hard small denticles, is used both as a polishing medium for wood and ivory, and as ornamental leather. The liver has a high vitamin content.



Skates and Rays

"WINGED SHARKS"

The Skates and Rays of the present may be regarded as transformed Sharks, in which the body has become greatly flattened and the pectoral fins enlarged and widened into "wings," which have finally become the principal organs of locomotion. The tail, in extreme cases, is reduced to a long, trailing rudder. The gill slits have been displaced onto the lower side and the water for the gills is pumped in and out through the large spiracles, or breathing holes, behind the eyes.

Several still existing forms show some of the stages by which this transformation has been brought about. The Monkfish (*Squatina squatina*) is, in fact, more or less intermediate between the Spiny Dogfishes and the Rays. Its pectoral fins are enlarged, but are still separated from the head by the gill slits, which remain lateral in position. The skull and jaws also are of the primitive sharklike type.

In the Guitarfishes (*Rhinobatus*) the front part of the enlarged pectoral fins is fastened

←Adaptive branching from primitives to "winged sharks" (Skates and Rays)

From W. K. Gregory

to the side of the head, and the gill slits are on the lower surface.

The true Sawfishes (Pristidae) are essentially like *Rhinobatus* in form. The greatly prolonged snout has acquired a row of "teeth" on either side. These, like the teeth in the mouth of Sharks, have been evolved out of denticles on the surface of the skin.

The Electric Rays, or Torpedoes, are capable of giving a powerful electric shock. The organs involved are believed to be specialized derivatives of the pectoral fin muscles and their nerves. They are the subject of investigation at the present time.

In certain Eagle Rays, the front ends of the pectoral fins begin to project beyond the mouth, and in the Manta or Devilfish, these give rise to movable flaps or "horns" which appear to assist the fish in scooping into its broad mouth the small floating creatures upon which it feeds.

The Sting Ray has a whip tail, bearing at its base a strong, saw-edged spine which can inflict a severe and irritating wound. In the Sting Rays and Eagle Rays the teeth are combined into great curved crushing plates with which the fish crushes the shells of oysters and clams.

The Skates lay eggs enclosed in tough, horny coverings, the four corners of which are prolonged into filaments. These egg cases are frequently washed up on northern beaches. In the Sting Rays and Eagle Rays the young are developed in the egg duct and the embryos draw their nourishment from the mother by means of filaments extending from their gill openings.

From a painting by A. Operti

Russell J. Coles harpooning a Devilfish (*Manta*)

Silver Sharks

CHIMAEROIDS

The existing Chimaeroids, or Silver Sharks, nearly all deep-water forms, are the descendants of certain specialized Sharks

A Silver Shark (*Chimaera monstrosa*)

A.M.N.H. photograph

of the Jurassic and Devonian periods. (See Fossil Fishes, page 86.) The living *Rhinochimaera,* with its long rostrum and tapering tail, strongly recalls this ancient stock, while *Harriotta,* a black fish from the great depths of the Atlantic and Pacific, looks like a caricature of *Rhinochimaera.* These fishes progress chiefly by means of their winglike pectoral fins. Their teeth and powerful jaws are adapted for biting and crushing. In external appearance, as well as in their cartilaginous skeleton and general anatomy, they are clearly allied with the Sharks, although in certain other features they parallel the higher fishes. Their mode of development is sharklike. Their eggs are enclosed in tough, horny egg cases, which probably lie on the sea bottom. When the young are ready to escape, the egg case opens along hingelike folds.[1]

Lungfishes
DIPNOANS

All fishes breathe oxygen dissolved in the water that passes over their gills, but there are a few which also have true lungs by means of which they can breathe even when the water in which they live dries up. These are the famous Lungfishes of Australia, Africa, and South America.

These interesting relics of long past ages (see pages 26 and 27) also have four limbs which are equivalent to the fore and hind limbs of land-living animals. The Lungfishes are distantly related to the ancestors of the swamp- and land-living amphibians.

The Australian Lungfish, *Epiceratodus,* is found today only in the Burnett, Dawson, and Mary Rivers, in Queensland, Australia, where it is well known as the Barramunda and valued as food. Many millions of years ago its ancestors left their peculiar fan-shaped dental plates and other traces in the swamps of the Devonian and subsequent ages in many parts of the world, from Pennsylvania to India and from Great Britain to Australia. The Australian Lungfish lives in stagnant pools or waterholes and rises at irregular intervals to the surface, protruding its snout in order to empty its lungs and take in fresh air. The development of this fish from egg to adult is reproduced on page 11.

The African Lungfish, *Protopterus,* and the South American Lungfish, *Lepidosiren,* resemble each other in general appearance and in habit. Both live in swampy regions which dry up partially or entirely during some months of the year. At the approach of these dry seasons, the fish burrows down into the mud where it aestivates until the land is sufficiently covered with water for it to emerge again. In aestivating condi-

[1] These fishes and their development have been described in detail by Bashford Dean, in his "Chimaeroid Fishes and their Development." *Publications of the Carnegie Institution of Washington,* 1906, no. 32, 195 pp., 144 figs., 1 pl.

The Australian Lungfish (*Epiceratodus forsteri*) which lives in stagnant pools and rises at intervals to take fresh air into its lungs

Drawing by D. Blakely

A Lungfish aestivating in its burrow, with its tail curled over its nose. A small air hole has been left in the dried and caked mud at the top of the burrow so that it can breathe

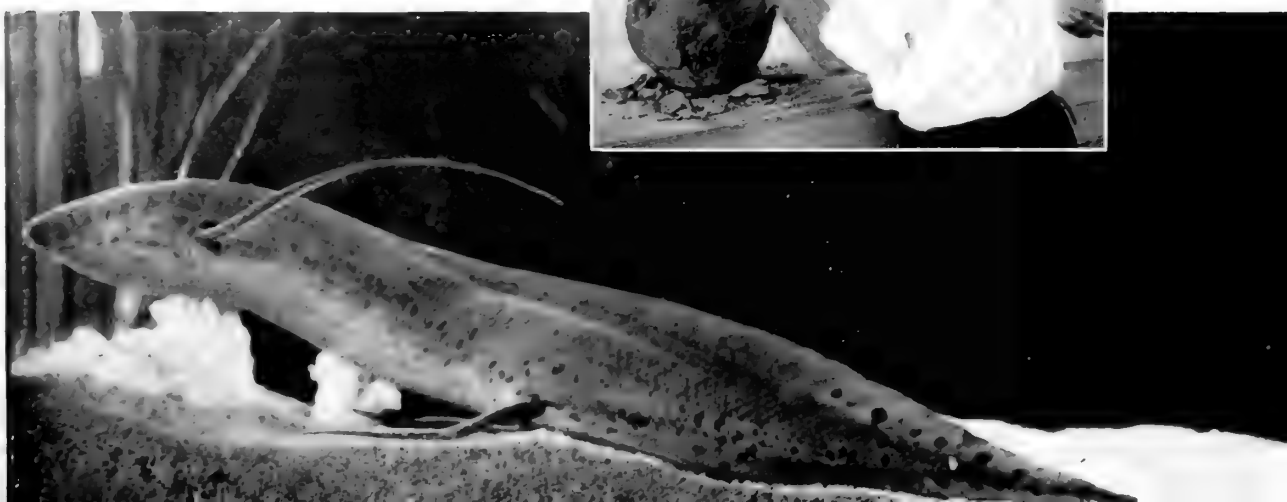
A lump of clay containing an African Lungfish (*Protopterus*), which has been hacked out of the dry swamp in Africa and shipped to New York

A.M.N.H. photographs

tion, these fish have been frequently shipped overseas encased in dried mud, from which on arrival they are carefully chiseled out and put in tanks where they live and thrive. During aestivation they live on stored fat and are able to breathe through small airholes left in the mud at the top of the burrow.

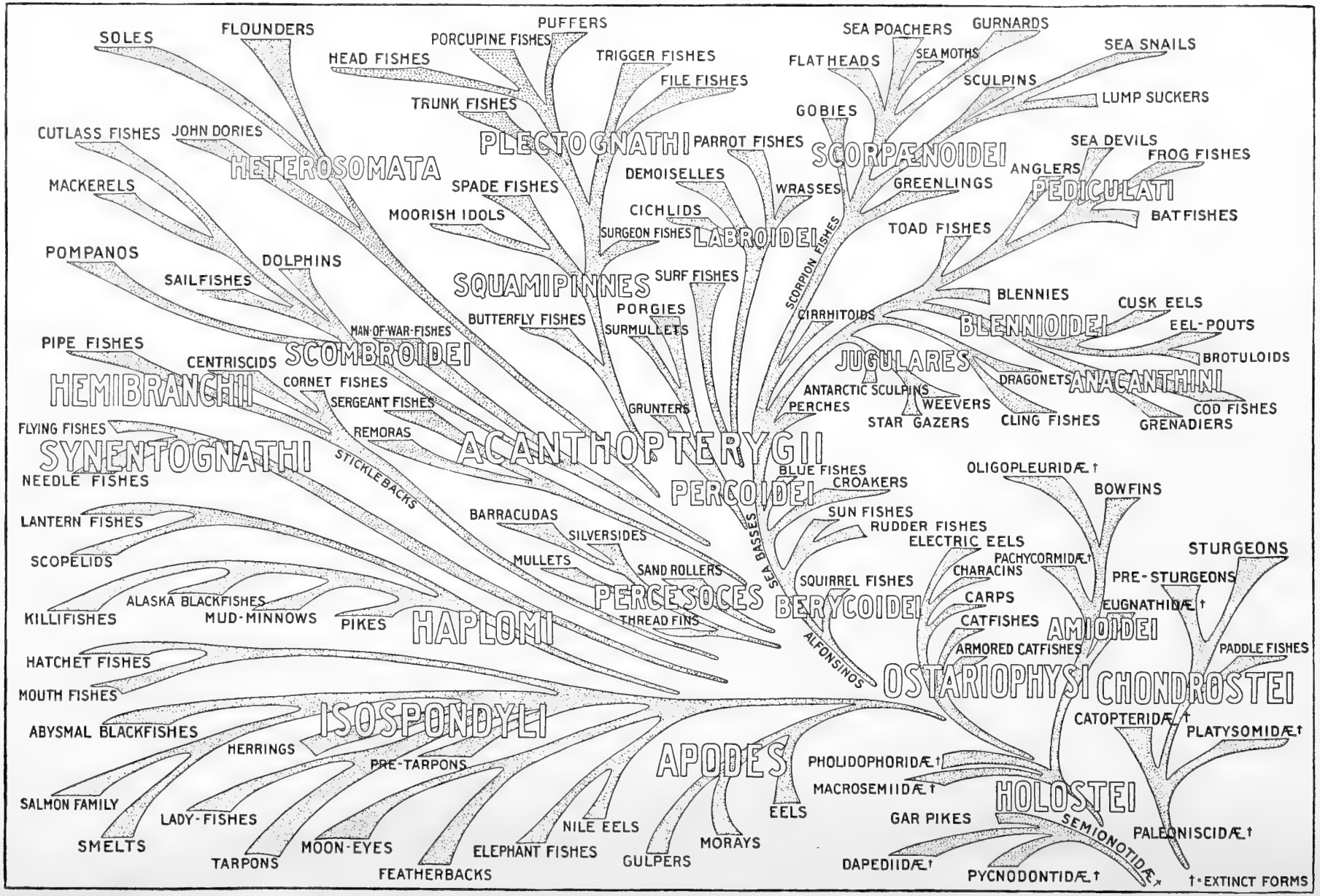
In the laboratory in New York, the hard clay is carefully chiseled from the encased Lungfish

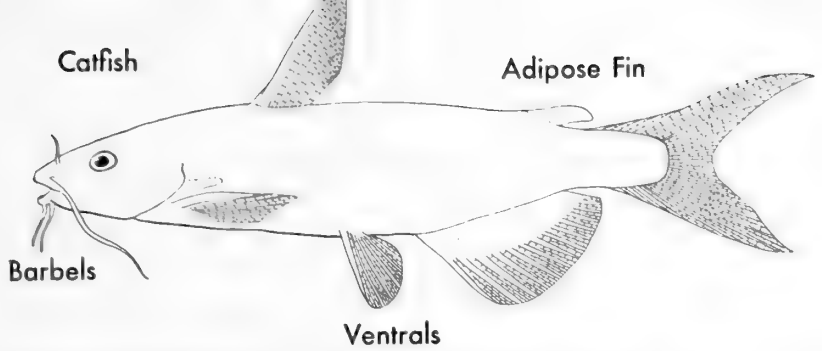
The living Lungfish, now released from its burrow, swims around in an aquarium tank



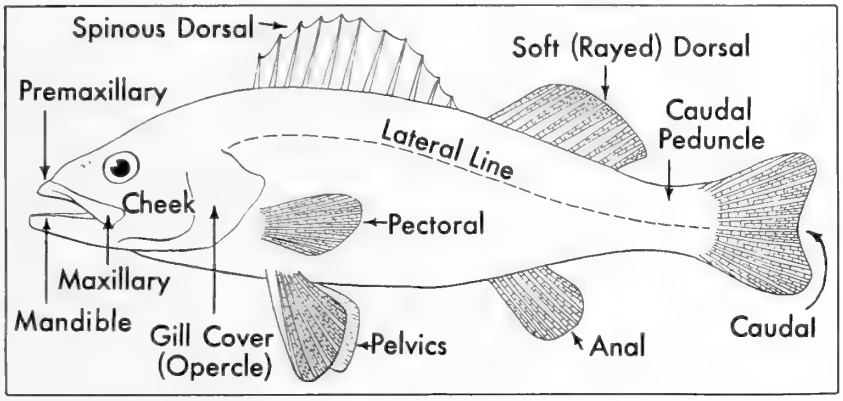
After W. K. Gregory

FAMILY TREE OF FISHES





The external diagnostic features of two kinds of Teleost fishes: Catfish and Bass. The ventral fins are also called "pelvics"



Drawings by J. Roemhild

The Higher Fishes

(Lobe-fins, Ganoids, Teleosts)

Lobe-fins

CROSSOPTERYGIANS

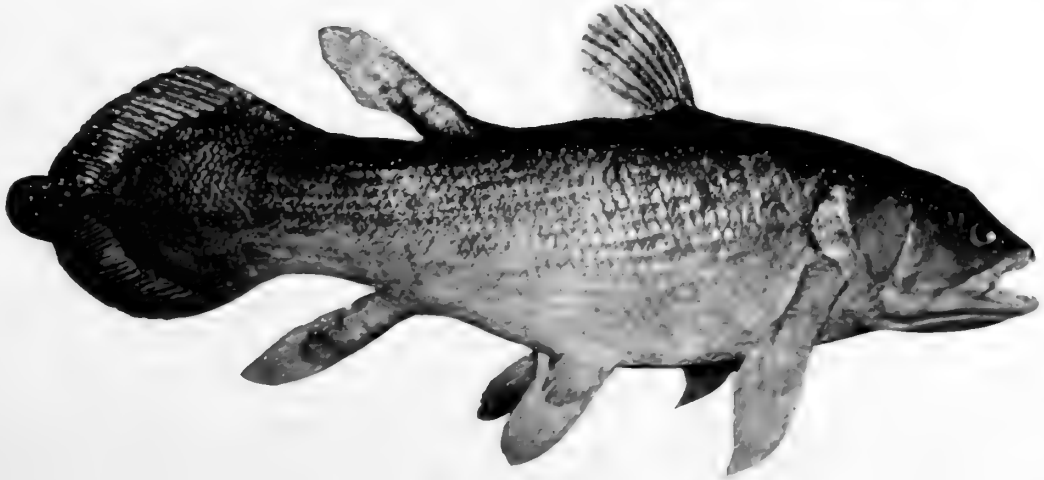
This group of extinct fishes is represented today by a single known species, *Latimeria chalumnae,* of which the only specimen so far captured was taken by fishermen in December, 1938, off East London, South Africa.

Its pectoral and pelvic fins are provided with a prominent muscular basal lobe, whence the name Lobe-fins.

The remote ancestors of *Latimeria* were related to the ancestors of the earliest four-footed animals, and there is evidence that their muscular paddles were transformed into the paired limbs.

A famous discovery: The modern Coelacanth (*Latimeria chalumnae*), netted in 1938. This antiquated fish from the Age of the Dinosaurs represents a group quite distinct from the "ordinary" bony fishes and sharks. It is the only living Crossopterygian. It fought viciously when brought up off East London, South Africa. Length, 5 feet; weight, 127 pounds

Courtesy East London Museum; world copyright strictly reserved



"Living Fossils"

THE GANOIDS

Some three hundred million years ago, the remote ancestors of these living fossils were the Old Ganoid fishes of the Devonian period. These were, in general, sharklike forms, but their bodies were covered with an armor of shiny "ganoid" scales (see Fossil Fishes, page 87). In 1833, Louis Agassiz classified them according to the character of their scales. His Ganoid group included all those in which the scales were covered externally with a thick, shiny, enamel layer, whence the name Ganoid, meaning "glistening."

The ancestral Ganoid fish (*Palaeoniscus*) had large jaws and piercing teeth, and the skeleton was partly cartilaginous.

Each living survivor of this ancient world retains some of the features of its ancestors, but each has also acquired certain specializations of its own.

The Paddlefish of the lower Mississippi River retains the ancient body form but has lost most of its scales and has acquired a spoonbill snout.

The Sturgeons also retain the sharklike form, but their mouth is sucking in type and the body is covered with bony plates. They are well known commercially because

A.M.N.H. photograph

The Shovel-nosed Sturgeon: an exhibit in the American Museum

The Garpike (*Lepidosteus*) alone has inherited the complete ganoid armor of rhombic, enameled scales; its skeleton is completely bony

A.M.N.H. photograph

of the use of their roe as caviar, and their airbladder as isinglass.

The Garpike alone has inherited the complete ganoid armor of rhombic, enameled scales, but its skeleton is completely bony.

The Bowfin (*Amia*) which is a descendant of the later, or New Ganoid, stock, is the most advanced of the series and has almost attained the rank of the Teleosts or higher fishes.

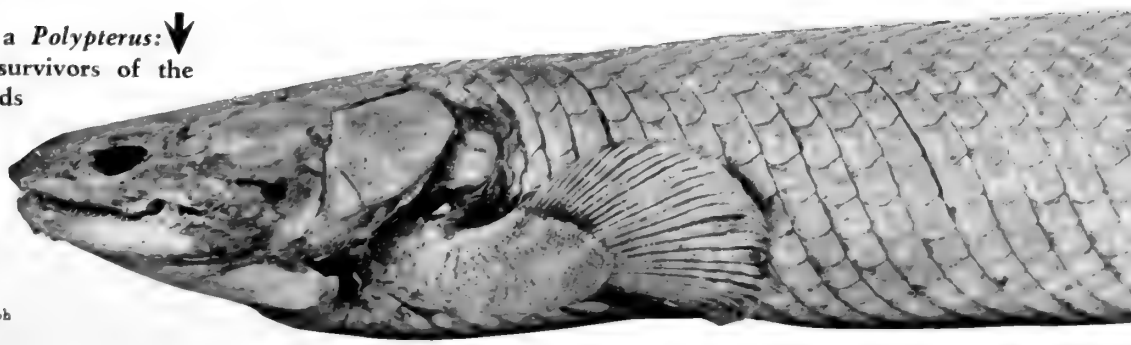
The Bichir (*Polypterus*) of tropical African rivers is another surviving Ganoid. Its cylindrical body is covered with ganoid scales and the head with a bony mask. The tail has become fan-shaped and is strengthened by rays consisting of vertical rows of scales joined end to end. The dorsal fin is divided into many finlets (*Polypterus* means "many fins").

In a related fish, *Calamoichthys,* from West Africa, the body is very long, almost like that of an Eel. In both genera, the paired fins are paddles, with a stout muscular base and strong radiating dermal rays. Partly on this account, *Polypterus* was long classified as a survivor of the fossil Crossopterygians or Lobe-fins (see page 86), but good authorities now regard it as a modern descendant of the basal Ganoid stock.

A.M.N.H. photograph

↑The Bowfin (*Amia*) and its nest. The male fish guards the eggs and is said to protect the young (From an American Museum exhibit)

The skin of a *Polypterus:* ↓ One of the survivors of the ancient Ganoids



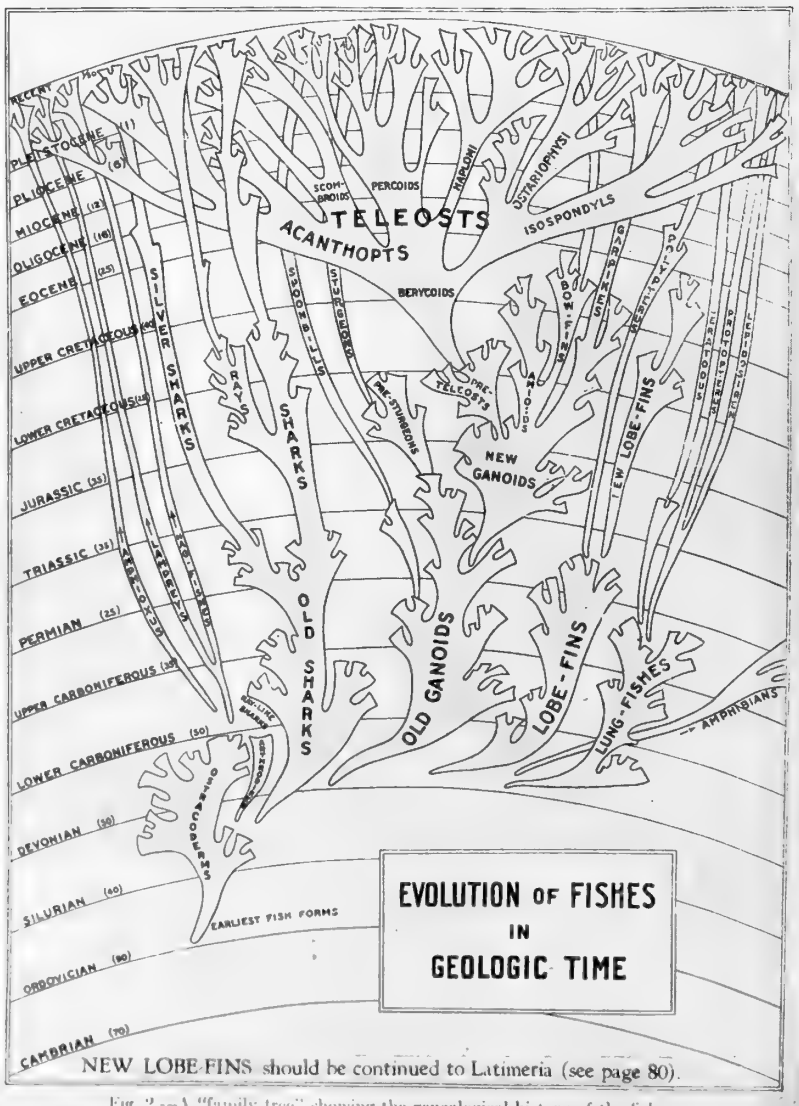
A.M.N.H. photograph

The Teleosts

During the Cretaceous period (roughly 60 to 120 million years ago), when the giant dinosaurs ruled the land, the mail-clad Ganoid fishes were largely crowded out by their more highly evolved descendants, the Teleosts, which at present constitute about 90 per cent of the fish fauna of the world. The name Teleost, meaning "completely bony," refers to the fact that the notochord, or primitive axial rod, of the larval stages of development is replaced in the adult fishes of this division by complete, bony, vertebral bodies or centra.

A simplified "family tree" showing the geological history of the fishes. The estimated duration of each geologic period is given in millions of years

From a wall chart in the American Museum



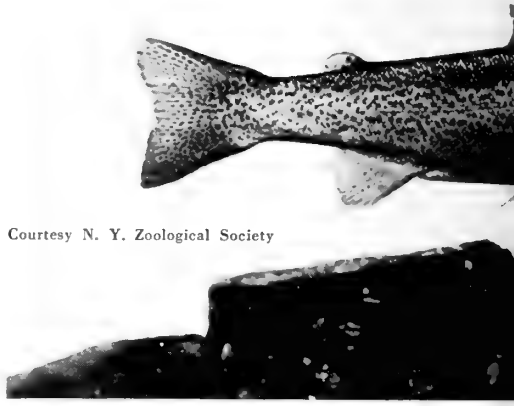
NEW LOBE-FINS should be continued to Latimeria (see page 80).

Fig. 2.—A "family tree" showing the genealogical history of the fishes

ORDER ISOSPONDYLI
(Tarpons, Herrings, Trouts, etc.)

This order, a main subdivision of the Teleost series, is a rather loose assemblage of fishes higher in rank than the Ganoids but lower than the spiny-finned fishes (Acanthopterygii). It includes such veterans as the Bonefish (*Albula*), the Tarpons, and the Herrings—all survivors from the dawn of Teleost history in the Cretaceous period (60 to 120 million years ago). It also embraces the more modernized Trouts, Salmons, etc., which are the younger scions of an ancient branch and date only from the Miocene epoch (approximately 7 to 20 million years ago). Between these two divisions come the Osteoglossids, dating from

Rainbow Trout



Courtesy N. Y. Zoological Society

***Osteoglossum*, a small species related to the giant Arapaima of South America**

Courtesy N. Y. Zoological Society

the Eocene (between 35 and 60 million years ago).

Beneath a great diversity of outward form, the Isospondyli are essentially conservative fishes, retaining the soft, or branched, fin rays of the Ganoids, the primitive duct of the air bladder connecting it with the throat, and the abdominally inserted ventral fins. The name Isospondyli means "equal vertebrae" and refers to the fact that, in contrast to the fishes of the Carp-Catfish order, the first four vertebrae behind the skull are not strongly modified.

The order Isospondyli, while vastly outnumbered in species by the higher orders of Teleosts, includes a very wide range of body form in adaptation to different modes of locomotion, and of jaws, teeth, and snouts in adaptation to different methods of feeding.

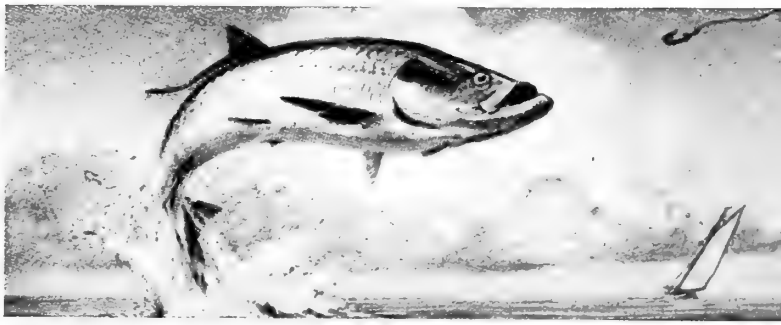
THE HERRINGS AND TARPONS: The oldest members of this order are the Leptolepidae of the Jurassic (about 120 to 155 million years ago)—small, herring-like Teleost fossil fishes of very generalized type. Next in line come the existing Bonefishes and their Cretaceous and Eocene ancestors, while the Herrings and the Tarpons follow at no great distance. The Tarpons are related to the Herrings through the fossil *Thrissopater*, from the Cretaceous.

The Herrings (Clupeidae) travel along the coasts in vast shoals, feeding on the myriads of minute forms, such as copepods and diatoms, which they strain out of the water by their gill rakers.

THE ELEPHANT FISHES (Mormyridae) are a highly specialized fresh-water group, apparently allied with the Albulidae. These strange fishes of the Nile River were venerated by the ancient Egyptians, who believed that the Mormyrids had eaten a piece of the body of the god Osiris.

A Tarpon leaping

Drawing by D. Blakely



The Elephant Fish (*Mormyrus kannume*), in New York Aquarium

Courtesy N. Y. Zoological Society

A.M.N.H. photograph

Atlantic Salmon on display in the Hall of Fishes of the World

THE MOONEYES OR GOLDEYES (Hiodontidae) are herring-like fishes of the fresh waters of North America. They stand near the common center of a number of other specialized relics of long past ages, such as the Featherbacks (Notopteridae) of West Africa, India, and Sumatra, and the Osteoglossidae from eastern South America, West Africa, and the Malay-Australian region (see chart page 28).

THE DORAB (*Chirocentrus*) of the Indian Ocean is the dwarfed survivor of a Cretaceous family that includes the gigantic *Portheus* (see Fossil Fishes, page 89).

THE SALMON AND TROUT (Salmonidae) are the highest and most beautiful members of the soft-rayed group of fishes. They are limited to the northern world, except for those that have been transplanted to New Zealand and Tasmania. They delight in cool waters, and many species of trout are found in the lakes and streams that were left by action of the great glaciers of the Ice Age.

The Salmons are famous for their habit of coming up from the sea to spawn, traveling upstream sometimes hundreds of miles, jumping the rapids and penetrating as far as possible toward the purer waters of the north. At the end of this journey they release the eggs and milt that give rise to the next generation. After spawning, the Pacific Salmons die, and in Alaska the streams are choked with their dead bodies, so that sea gulls fly many miles inland to feed upon them. The young salmon, or parr, gradually make their way down to the sea. The life cycle of the Chinook Salmon is illustrated in a miniature group in the American Museum's Hall of Fishes.

The Salmons and Trouts, unlike their relatives the Herrings, are predaceous fishes with strong teeth. The family, as far as is known, dates only from the Miocene (about 7 to 20 million years ago).

DEEP-SEA RELATIVES OF THE SALMON AND TROUT: The fantastic forms and coloring of the Boa Fishes (Stomiatidae and related families) are in keeping with the world of darkness and cold in which they live and breed their sensitive young. Their large eyes serve to catch the phosphorescent glow produced by other creatures, while their own light-producing organs, marked by

spots on the sides of the body, serve to attract their prey.

The Stalk-eyed Fish: Ichthyologists had long known these minute, deep-sea fishes, whose eyes were placed at the ends of long stalks, and had called them *Stylophthalmus*. In 1934, Dr. William Beebe showed that these Stalk-eyed Fish were merely the young of a very different looking adult fish with normal eyes—*Idiacanthus*. The American Museum has an exhibit showing the stalk-eyed stage, a later stage in which the eye stalks are shortening, and, finally, the adult stage where the eyes have finally been drawn back into sockets in the skull in the normal position.

The males of *Idiacanthus fasciola* are only about 1½ inches long; the females are seven times larger. The digestive tract of the males is reduced and functionless, and they have no teeth; the females have a carnivorous digestive tract and large teeth.

Dr. Beebe collected the larval fish off Bermuda at 100 fathoms, the adults at between 500 and 1000 fathoms.

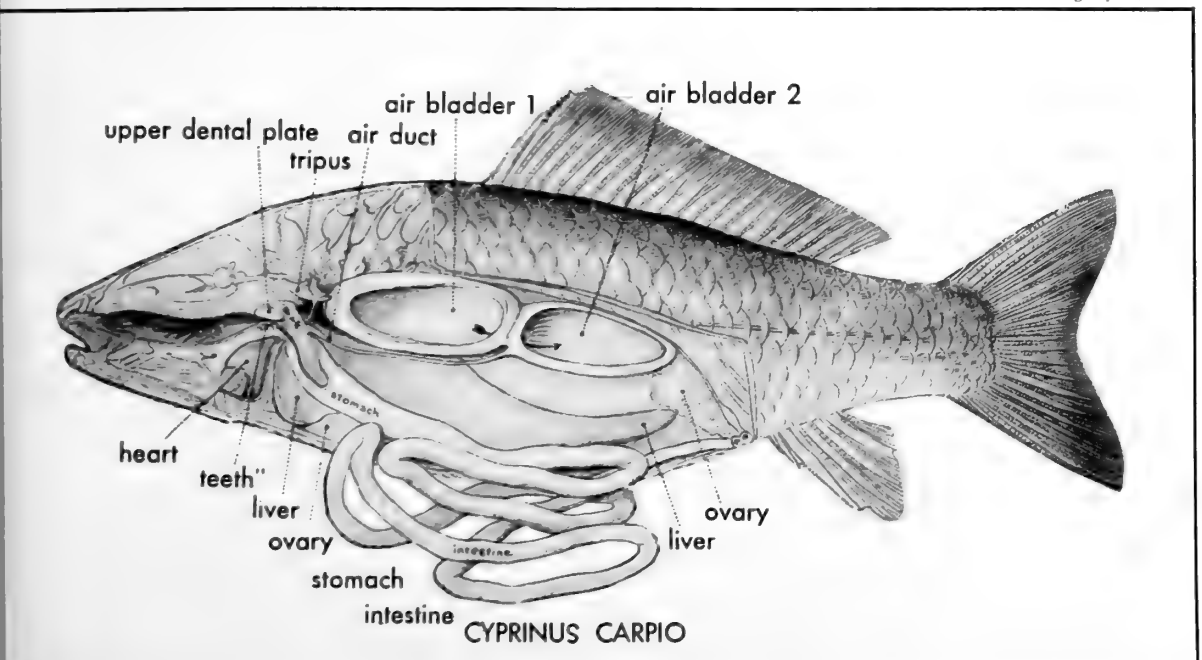
ORDER OSTARIOPHYSI
(Characins, Carps, Catfishes, etc.)

The members of this order are nearly all fresh-water fishes. Its most specialized members, the Catfishes, date from the Eocene epoch (35 to 60 million years ago), so the earlier ancestral forms must be sought perhaps in the Cretaceous. Thus the group may have been derived from some very early Teleosts, possibly the Leptolepidae of the Jurassic.

THE WEBERIAN APPARATUS: The members of this group possess one of the most remarkable of all animal mechanisms—the Weberian apparatus. This consists chiefly of a linked series of small bony levers and springs which is attached at the lower end to the swim bladder and at the upper end to the back of the so-called inner ears, or organs of balance. Some authors hold that this apparatus serves to collect pulsations coming in from the water, to modify them, and to transmit them to the nerves of the internal ears. Others hold that its chief function is to transmit not sounds but sensations of varying pressure. The small bony levers and springs represent highly modified ribs and other parts of the first four vertebrae behind the skull. This apparatus is found in no other order of fishes.

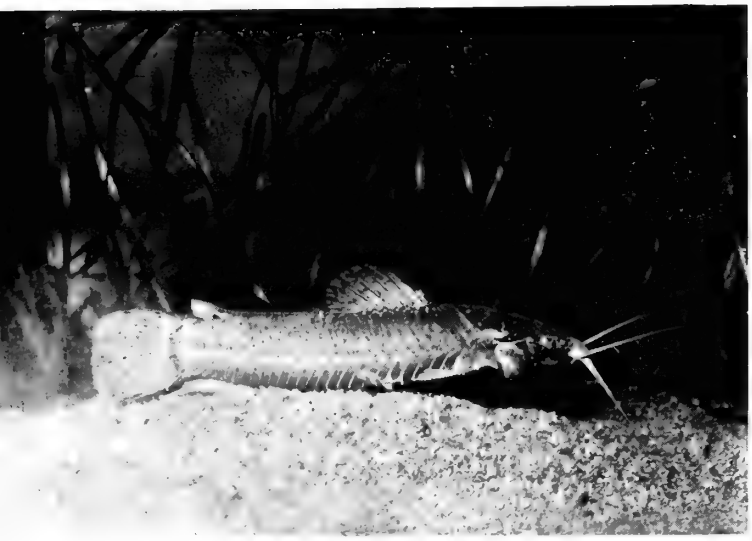
Anatomy of the carp, showing "teeth" in throat and long intestine. The "tripus" transmits vibrations from the air bladder to the inner ear

Drawing by L. Nash



Courtesy of N. Y. Zoological Society

The Common Bullhead, typical of the abundant Catfishes of North America



Courtesy of N. Y. Zoological Society

One of the Armored Catfishes: *Callichthys*. The armor consists of a double row of overlapping shields on both sides of the body

Courtesy N. Y. Zoological Society

An Armored Catfish, *Plecostomus*, in the New York Aquarium. These fishes are covered on the back, head, and sides with bony plates, sometimes armed with small, prickly spines. The under part of the body is often unprotected. *Plecostomus* spends much of its time clinging to the stones of stream beds

to have been derived from combinations of highly specialized parts of the muscular and nervous systems.

Catfishes (Suborder Nematognathi): Catfishes are the scavengers of the river bottom mud. Their scaleless, slimy bodies are covered with sensory cells that taste the food dissolved in the water. The long barbels around the mouth doubtless aid them in feeling their way about in the semi-darkness and partly compensate for their very small eyes. The teeth are small or lacking, and the mouth serves as a wide scoop. The maxillary, or rear bone of the upper jaw, is reduced to a small movable base for the main barbel, whence the name Nematognathi, or "thread-jaw." The pectoral and dorsal fins bear strong spines which are often dangerous weapons.

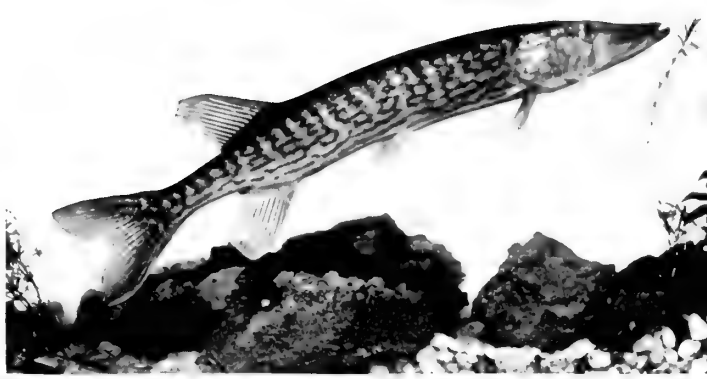
Catfishes have lost their scales, but some of them, especially the Armored Catfishes (Loricariidae), have acquired secondary derm-bone plates covering the body.

ORDER HAPLOMI
(Pikes, etc.)

This order is intermediate in its anatomical characters between the Isospondyli, or lower Teleosts, and the spiny-finned, or higher Teleosts. The name Haplomi ("simple shoulder") alludes to the simplified character of the shoulder girdle, which lacks the mesocoracoid arch or middle inner brace of the bony base of the pectoral fin.

This structure is present in all Ganoids and lower Teleosts, in which the pectorals are held in a more horizontal plane, but it is lost in the higher ones, in which the resting pectorals are held in a more vertical plane.

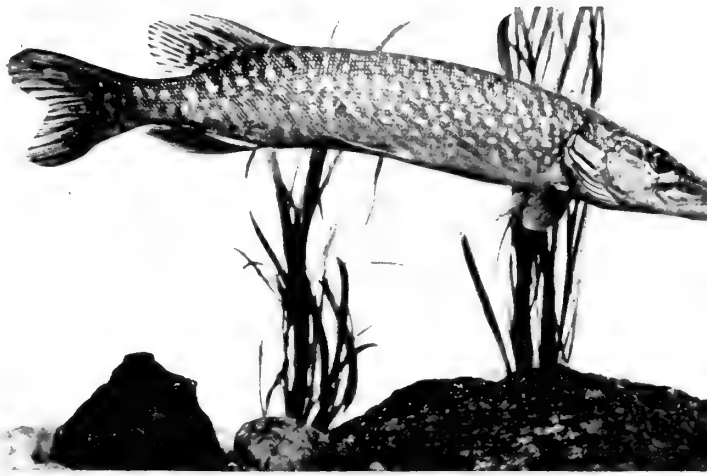
The Pikes, Pickerels, and Muskellunge lie in wait for their prey, making swift rushes to snap it up with their long, sharp-toothed jaws. They employ the same technique in taking bait and are very game fighters when hooked.



Photographs from live specimens in the tanks of the New York Aquarium

Pickerel

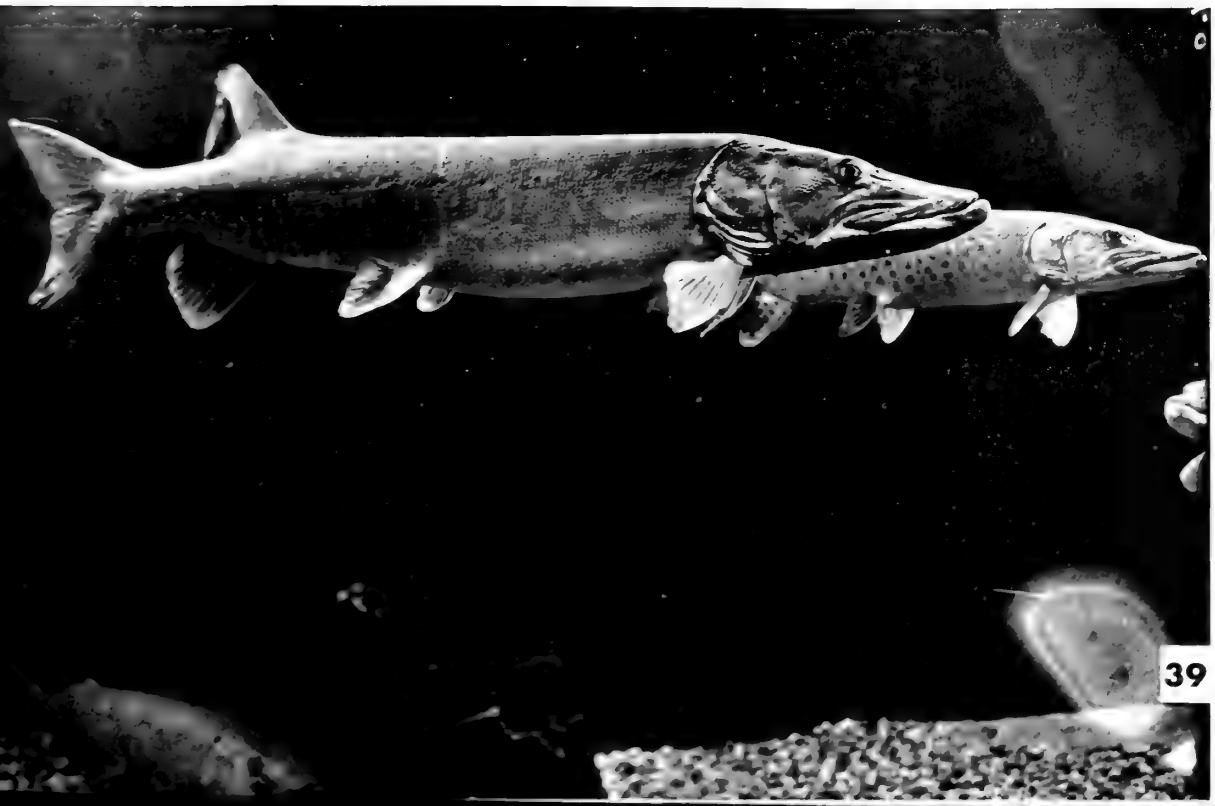
Pike



ORDER CYPRINODONTES
(Microcyprini)

This order includes the Killifish family, several members of which have been successfully used in mosquito destruction. They are small fishes with tiny mouths, but they retain the pikelike backwardly placed

Muskellunge



A SIMPLIFIED PICTORIAL CLASSIFICATION

ORDER OSTARIOPHYSI
Characins, Carps and Catfishes

Family Characidae
Characins

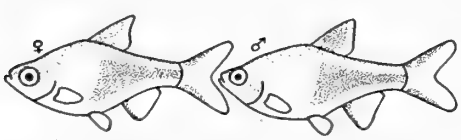
Copeina, Brazil
Copeina guttata (Steindachner)

Blood fin, Argentina
Aphyocharax rubripinnis Pappenheim

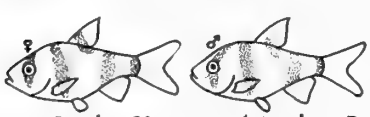
Black Tetra, South America
Gymnocorymbus ternetzi (Boulenger)

Family Cyprinidae Carps

Zebra fish, India
Brachydanio rerio (Hamilton-Buchanan)

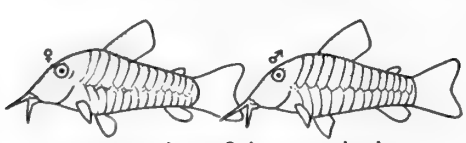


Red Rasbora, Malay and Sumatra
Rasbora heteromorpha Dunker



Sumatra Barb, Siam and Malay Pen.
Barbus partipentazona Fowler

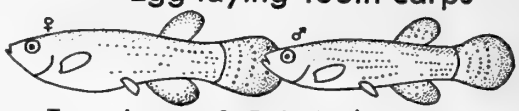
Family Callicthyidae Catfishes



Armored catfish, Trinidad
Corydoras aeneus (Gill)

ORDER CYPRINODONTES
Killifishes, Top-minnows, etc.

Family Cyprinodontidae
Egg-laying tooth-carps

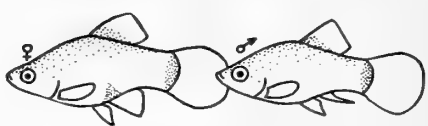


Top-minnow, S. E. United States
Fundulus chrysotus Holbrook

Chaperi, West Africa
Epiplatys chaperi (Sauvage)

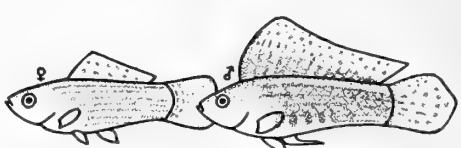
Bivittatum, West Africa
Aphyosemion bivittatum (Loennberg)

Family Poecillidae Live-bearers



Moonfish, Mexico
Platypoecilus maculatus Guenther

Sword tail, Mexico
Xiphophorus helleri Heckel



Sail-fin Mollie, Southern U. S. and Mexico
Mollienisia latipinna Le Sueur

Guppy, Northern South America
Lebistes reticulatus (Peters)

Belonesox, Honduras
Belonesox belizanus Kner

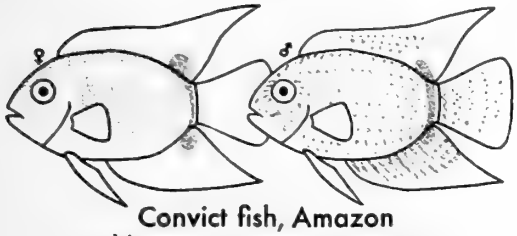
OF THE MORE COMMON AQUARIUM FISHES

ORDER PERCOMORPHI

Cichlids, Nandids, etc.

Family Cichlidae
Cichlids

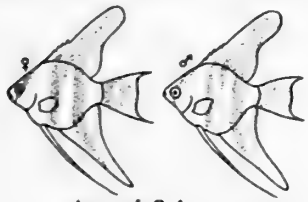
Mouthbreeder, Egypt
Haplochromis multicolor (Hilgendorf)



Convict fish, Amazon
Cichlasoma severum (Heckel)

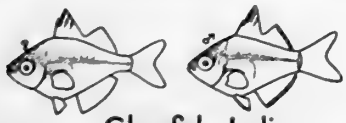
Flag Cichlid, Brazil
Cichlasoma festivum (Heckel)

Jack Dempsey, South America
Cichlasoma biocellatum Regan



Angel fish, Brazil
Pterophyllum scalare
Cuvier and Valenciennes

Family Ambassidae Ambassids

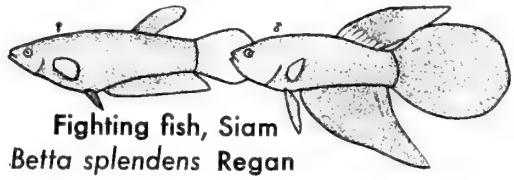


Glassfish, India
Ambassis lala (Hamilton-Buchanan)

ORDER LABYRINTHICI

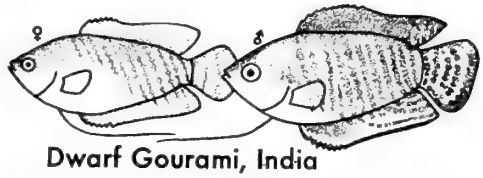
Anabantids, etc.

Family Anabantidae
Anabantids



Fighting fish, Siam
Betta splendens Regan

Paradise fish, Asia
Macropodus opercularis (Linnaeus)



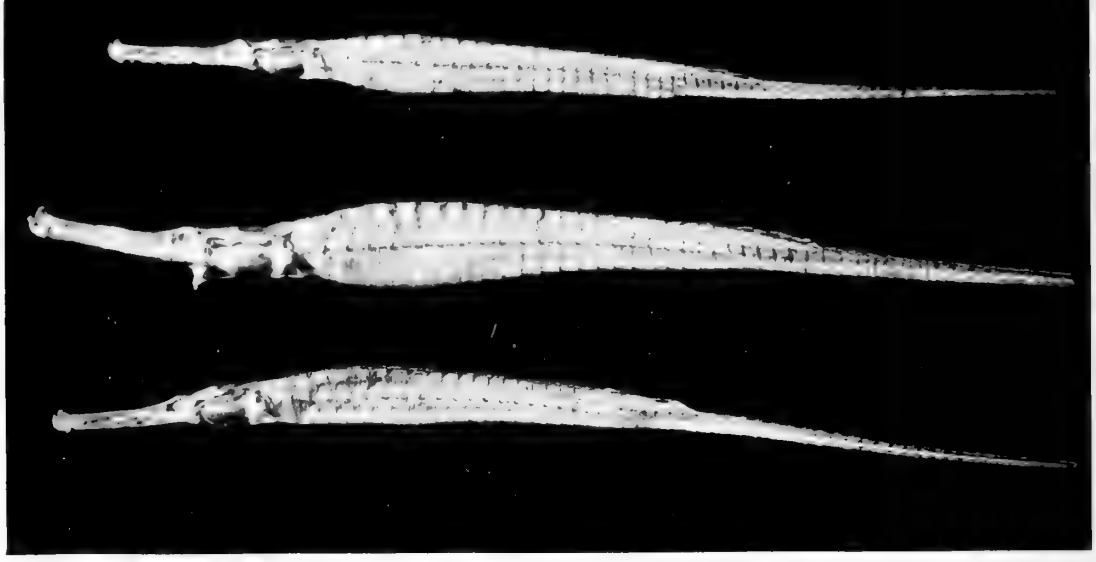
Dwarf Gourami, India
Colisa lalia (Hamilton-Buchanan)

Pearl Gourami, Malay Pen., Siam
Trichogaster leeri (Bleeker)

Kissing, Gourami, Malay region
Helostoma temmincki Cuvier and Valenciennes

D. Marcy

Chart by D. Marcy



A.M.N.H. photograph

↑Pipefishes. These are relatives of the Sea Horse but are less specialized and more fishlike in form and movements

dorsal and anal fins, and broad tails that enable them to make swift turns.

Owners of "tropicals" do not need to be told that their beloved Guppies are live-bearers! The same is true of Mollies, Swordtails, Platies, and a number of others. The young are active at birth and able to forage for themselves. These "Live-bearing Toothed Carps" are nearly all members of a single family, the Poeciliidae. The majority of the "Egg-laying Tooth Carps," including *Rivulus, Fundulus, Panchax,* etc., are members of the family Cyprinodontidae. In these fishes the ripe eggs are extruded and either stick to aquatic plants, drop to the bottom, or hang pendant from the female fish.

In the typical live-bearers (Poeciliidae), the anal fin of the male is modified into a groove (gonopodium) through which the fish deposits a capsule of sperm at the genital pore of the female. This internal fertilization permits the fertilized eggs to develop inside the body of the female, and the young are born alive. In the related Cyprinodontidae, however, the males having no such structure, fertilize the eggs at the time they are extruded from the female fish, and the embryonic development takes place in the water.

The Tooth Carps are not related to the true Carps (see page 36).

ORDER INIOMI
(Lizard Fishes)

These large-mouthed, needle-toothed fishes are in certain respects intermediate between the salmonlike forms of the soft-rayed order and the Pikes and their allies of the order Haplomi. Many of the deep-sea members of the family (Myctophids) have a series of light-producing spots on their body and head. These light organs have been developed independently in different groups of deep-sea fish. They appear to be essentially highly specialized lateral line scales, in which the surface layer has become transparent like a lens, while the chromatophores or pigment organs have produced both the silvery and black pigments, and the light giving substance, luciferin.

In some of the Lizard Fishes living at great depths, e.g. *Bathypterois,* the eyes are reduced or absent, and the rays of the pectoral fins are prolonged into delicate feelers.

The family is an ancient one, dating from the Upper Cretaceous period.

ORDER THORACOSTRACI

(Sticklebacks, Tubefish, Sea Horses, etc.)

This order includes a number of very peculiarly formed fishes, some of which swim in a vertical position.

THE STICKLEBACKS (Gasterosteidae): These fishes are so called because of the three or more isolated spines which represent the spinous dorsal fin. The smaller two- and three-spined Sticklebacks can be transferred from fresh to salt water or vice versa without harm, but the larger, fifteen-spined *Spinachia* is entirely marine.

The male Stickleback builds a nest of weeds, held together by a thready secretion from the kidneys. He then guards the eggs deposited by the female. These fishes are short lived and probably only breed once.

FISHES WITH TUBIFORM SNOUTS (Aulorhynchidae, Aulostomatidae, Amphisilidae, Centriscidae): The Aulorhynchidae are closely related to the Sticklebacks, but their elongate snouts approach those of the Trumpet Fishes or Aulostomatidae of the West Indies, Polynesia, and Asia. A species of *Aulostomus* is found in the Eocene of Italy.

The Snipefish, *Centriscus,* is heavier bodied than most of its relatives and bears a long spike on its dorsal fin. Its minute, toothless mouth is at the end of a long snout.

The Shrimpfish, *Amphisile,* has a long thin body enclosed in thin bony armor. This armor extends at the tail end of the body in a long spine which runs above and beyond the tail fin. *Amphisile,* like the Sea Horse, swims in a vertical position.

The Syngnathidae, which include the Pipefishes and the Sea Horses, are more or less elongate and are protected by a jointed armor of horny plates. The snout is prolonged and tubiform, and the tail is sometimes prehensile. In most species, the male takes charge of the eggs in a pouch under the tail or on the abdomen. By rapid vibration of their delicate pectoral and dorsal fins, these fishes move gently through the water, catching at floating weeds with their prehensile tails. The Australian Sea Horse, *Phyllopteryx,* is remarkable for the cutaneous appendages that float out from its body like seaweed.

The Northern Sea Horse, *Hippocampus,* is common on our coast in summer, from Charleston, South Carolina to Cape Cod, Massachusetts. There are various Sea Horses scattered around the marine waters of the world. They range in color from red to bright yellow. Our northern species is brown. They swim in a vertical position.

Australian Sea Horse

A.M.N.H. photograph

The Common Eel (*Anguilla bostoniensis*)

The Spotted Moray in a tank in the New York Aquarium. The Moray thrives in captivity and can be kept for years in aquarium tanks

Courtesy N. Y. Zoological Society

ORDER APODES
(The Eels)

The Eels have cast aside all superfluous fins, drawn out the smooth cylindrical body into a compressed tapering end, and multiplied the muscle segments until they can undulate as easily as a streamer waves in the wind (see page 13). In some families of Eels, the scales are entirely lacking, but in the most common Eel, *Anguilla,* they are present, although vestigial and imbedded.

The true Eels of Europe and America all go to the deep sea to spawn. There is an area south of Bermuda where all such Eels have been thought to spawn, and certainly they seek either this or similar ocean conditions. The eggs hatch flat, translucent larvae known as Leptocephali. These are so unlike the adult fish that they have sometimes been classified as distinct fishes. Those to the westward of the breeding area gradually drift, as they grow, toward America; those to the eastward, toward Europe. When they approach shore, they are several inches long. On entering coastal waters, they shrink and take on the appearance of Eels, although they are still more or less transparent. Some of them remain and grow in coastal salt or brackish waters, and others penetrate far inland, becoming the fresh-water Eels of the interior. A minature group in the American Museum's Hall of Fishes illustrates the life history of the Common Eel and the commercial utilization of this fish.

The Conger Eel does not enter fresh water. It moves away from the shore to spawn. Both it and the Common Eel die after spawning.

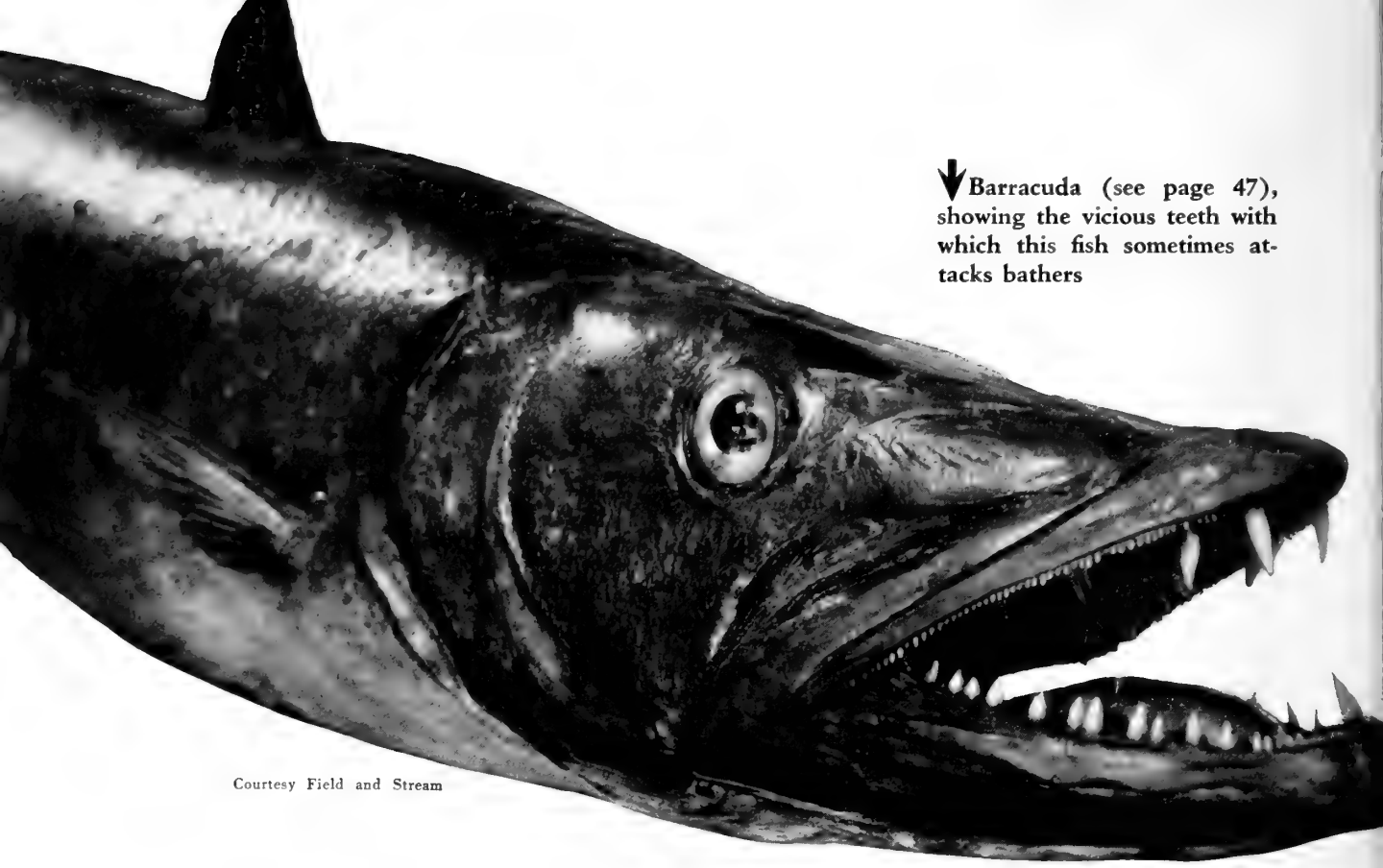
The Moray and the Conger are the largest of the Eel tribe. The Morays are typical reef fishes and have long jaws armed with sharp teeth. They differ from the Conger in their lack of pectoral fins and in the beautiful color patterns of their skin.

ORDER SYNENTOGNATHI
(Flying Fishes, Needlefishes, etc.)

Several unrelated groups of fishes have independently developed the ability to fly, but the Exocoetidae, or Marine Flying Fishes, excel all others in aerial powers. They are characteristic of the trade wind belts of open, tropical oceans. These, of all

Flying Fish and Airplane

Photograph by Lilo Hess



Courtesy Field and Stream

Barracuda (see page 47), showing the vicious teeth with which this fish sometimes attacks bathers

flying animals, most closely resemble the modern airplane. The proportions of the Flying Fish and the airplane are very close in spite of the difference in size.

Being an organic unit and not a rigidly articulated machine, the fish is capable of greater flexibility of movement and has some adjustments not yet possible in a plane. In both the Flying Fish and the airplane, the camber of the wings, their placement, and the presence of stabilizer fins at proper places are remarkably similar, considering the form, size, and landing requirements of each. One of the most striking differences is the complete absence of any landing gear on the fish. This is a notable economy which is possible because the fish can plunge into the water headfirst or drop without injury in a manner that would wreck a plane.

The average rise of these fishes above the water is about 5 feet, although they occasionally rise higher. The length of flight varies from 50 to 300 feet, but with the wind they have been observed to fly a quarter of a mile. Turning is accomplished by use of the body muscles and tail fin. The wings, when in flight, remain like the wings of a glider. The larger the fish, the longer the flight will be and the fewer the dippings of the tail into the water for added impetus.

About twice as many Flying Fishes fly in schools of two or more as fly alone. The predominant form in the Gulf Stream is *Parexocoetus mesogaster*.

The Flying Fish appears to be an offshoot from some early member of the spiny-finned order.

OTHER FLYING FISHES: Three other fishes not related to the Synentognaths have powers of flight. These are:

The South American Fresh-Water Flying Fish (*Gasteropelecus*), a small fish related to the Piranha and belonging to the family Characidae (page 36). This fish can make a flight of from 5 to 10 feet.

The African Fresh-Water Flying Fish

(Pantodon): This is a small Isospondyl related to the Herring-Trout group (page 32). It has very slight powers of flight.

The Flying Gurnard (*Dactylopterus*): This is one of the mail-cheeked fishes, related to the Sea Robins and Sculpins (page 56). The Flying Gurnard is said to leap above the water and glide on its relatively large breast fins for a short journey.

ORDER PERCESOCES
(Barracuda, Mullet, etc.)

The Barracuda *(Sphyraena)* is one of the most piratical looking of all sea-going crafts; a swift, fierce fish with a formidable array of large sharp teeth. It may be easily recognized by its silver and blue body, its pikelike form, and its separate spiny dorsal fin. This separate spinous dorsal is also a character of such peaceful kinsfolk of the Barracuda as the Silversides (Atherinidae) and Mullets (Mugilidae). The latter feed on other small animals, algae, and occasionally on vegetable matter. They resemble the Flying Fishes in the high position of their breast fins, and the group as a whole may be distantly related to that assemblage.

In the Malay-Philippine region there is a family of minute fishes believed to be closely related to the Silversides and Mullets. These are the Phallostethidae. In these fishes internal fertilization is effected by enlarged and modified pelvic fins and genital ducts, which in the males have been changed into an intromittent organ.

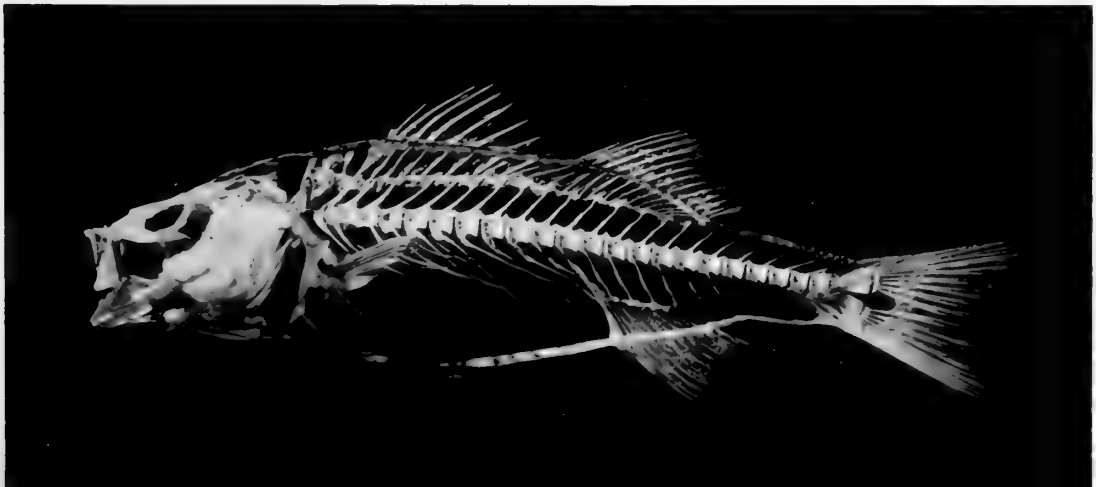
ORDER ACANTHOPTERYGII
(The Spiny-finned Fishes)

The vast majority of existing species of fish belong to the spiny-finned order, the most characteristic and unchanging features of which are illustrated in the skeleton of the Striped Bass. Usually the soft, branched rays of the dorsal and anal fins in these fishes are preceded by one or more sharp-tipped spines. There may also be such a spine preceding the rays of the pectoral and ventral fins. The typical body form of the spiny-finned fish is fairly stout, with a broad, strong tail base and bony tail—all signs of vigorous swimming ability. Another characteristic anatomical character is that the pelvis, or bony base of the ventral fins, is prolonged forward and connected to the shoulder, or pectoral, girdle where the lower two ends of the latter meet. This arrangement facilitates quick turning and stability.

These fishes usually have strong jaws and teeth, and prey upon other fish. The front upper jaw bone (premaxilla) is prolonged backward and downward so that it shuts out the second upper jaw bone in back of it (the maxilla) from immediate contact with the corner of the mouth. The maxilla is toothless and acts only as a lever for pushing forward the premaxilla.

Skeleton of Striped Bass

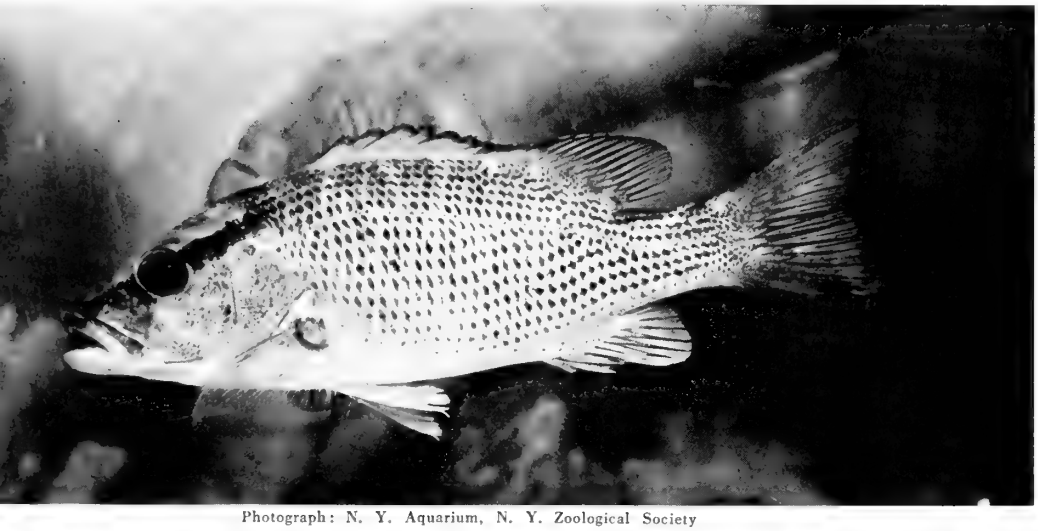
A.M.N.H. photograph



THE BASSES AND THEIR ALLIES (Suborder Percoidei): The true Basses (Serranidae) and their allies stand near the center of the great assemblage of spiny-finned fishes. They are mostly stout-bodied fishes, usually swift and voracious. Most of them prey upon smaller fishes, crabs, shrimps, and other crustaceans. Many are brilliantly colored and some, such as the Rockfishes, undergo pronounced color changes, sometimes having as many as four definite and very different color phases. Many factors in addition to conformation to the environment are involved in these changes.

The Snappers (Lutianidae) are carnivorous food fishes, closely allied to the true Basses, but often having a longer face from the tip of the upper jaw to the lower border of the eye. The back part of the upper jaw slips under the lower border of the enlarged front suborbital bone and is thus concealed when the mouth is closed. Above each ventral fin there is often a very much enlarged scale. These fishes are usually very brightly colored.

The Grunts (Haemulidae) are also called Roncos, from the Spanish verb *roncar* which means to grunt or snore. This refers



Photograph: N. Y. Aquarium, N. Y. Zoological Society

←Gray Snapper (*Lutianus*)

↓Yellow-striped Grunt (*Haemulon*)

Courtesy N. Y. Zoological Society

to the noise the fishes make either with the very large pharyngeal teeth or the complicated air bladder. These are also tropical fishes.

The Porgies (Sparidae) are well known in our markets through the Northern Porgy. In these fishes the pharyngeal or throat teeth become very large and pebblelike, and in one form, the Sheepshead, the front teeth of the upper and lower jaws are also strongly developed, so that with them the fish can pluck up crustaceans, which are then crushed by the teeth in the throat. The Porgies occur chiefly in warm waters and many of them are vividly colored, often with a ground color of crimson.

The Basses: The true Basses (Serranidae) include the Sea Bass, Striped Bass, the White Perch of this vicinity, the Rockfish and the Groupers of the Florida Keys and south, besides many others in various parts of the world.

Most of these have three well-developed anal fin spines, and the back part of the upper jaw is quite distinct when the mouth is closed. There are often one or two small spines on the upper corner of the gill cover.

Nassau Grouper (*Epinephalus*)

Courtesy N. Y. Zoological Society

The Sunfish Family (Centrarchidae): Fishermen apply the name Bass indiscriminately to basslike fishes belonging to other families as well as to the fishes named above. Such is the case with the Large-mouth Black Bass and the Small-mouth Black Bass, both of which actually belong to the Sunfish family (Centrarchidae), and the Channel Bass and California Sea Bass, which belong to the Weakfish family (Sciaenidae).

The Perches and Darters: These fishes of the family Percidae are plentiful in the fresh waters of the northern hemisphere. They have more vertebrae than the Basses, and only two spines in the anal fins. The majority of them are American. Both in Europe and in America, the Perches are popular game fishes. The Darters are characteristic of clear streams. They are small and brilliantly colored, with large fins. The largest Darter is about 6 inches in length.

The Cobia (Rachycentridae) is easily distinguished by its very definite markings—a conspicuous black stripe on either side of the body running from the tip of the snout to the tail and connected across the back of the head by a black saddle mark. The young of the Cobia presents a marked resemblance to the Shark Sucker (Echeneidae).

The Bluefish (Pomatomidae): This is a swift, carnivorous fish approaching the Mackerels in shape. The Bluefish, *Pomatomus saltatrix,* is one of our best known food and game fishes. The family contains only this one species.

The Triple-tails (Lobotidae): These are powerful, deep-bodied fishes. The anal and the dorsal fins extend fairly far to the back of the fin toward the tail, from which fact the name is derived.

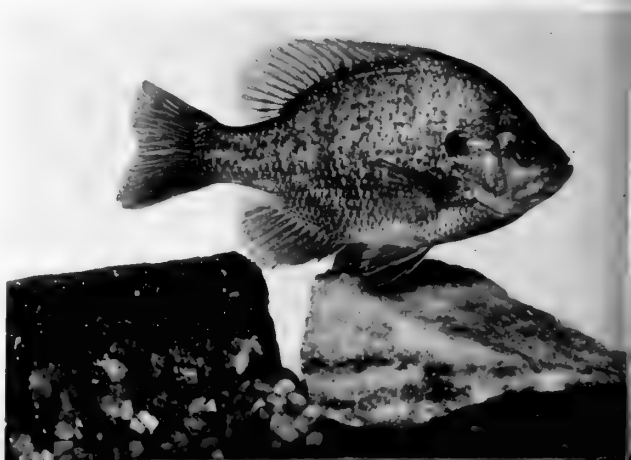
The Berycids (Berycidae): These are chiefly deep-sea forms, near relatives of the Squirrel Fishes.

The Squirrel Fishes (Holocentridae): These are tropical fishes usually living among coral reefs. They are apt to be red, or red striped with silver or yellow.

Croakers and Weakfishes: The Croakers (Sciaenidae) are closely related to the true Basses, but differ in their small anal fins, in which the spines are reduced. In the long dorsal fin there is a deep notch between the spiny and the soft-rayed parts, but no gap between the parts at their base. A system of large pits on the top of the skull lodges sacs containing the sense organs of the lateral line system.

Local members of this marine family are the Weakfish, Channel Bass, Spot, Croaker, Whiting (*Menticirrhus*), and Sea Drum. The latter has strong pebbly teeth in its

Sun Fish (*Lepomis*)



←Large-mouth Black Bass (*Huro salmoides*)

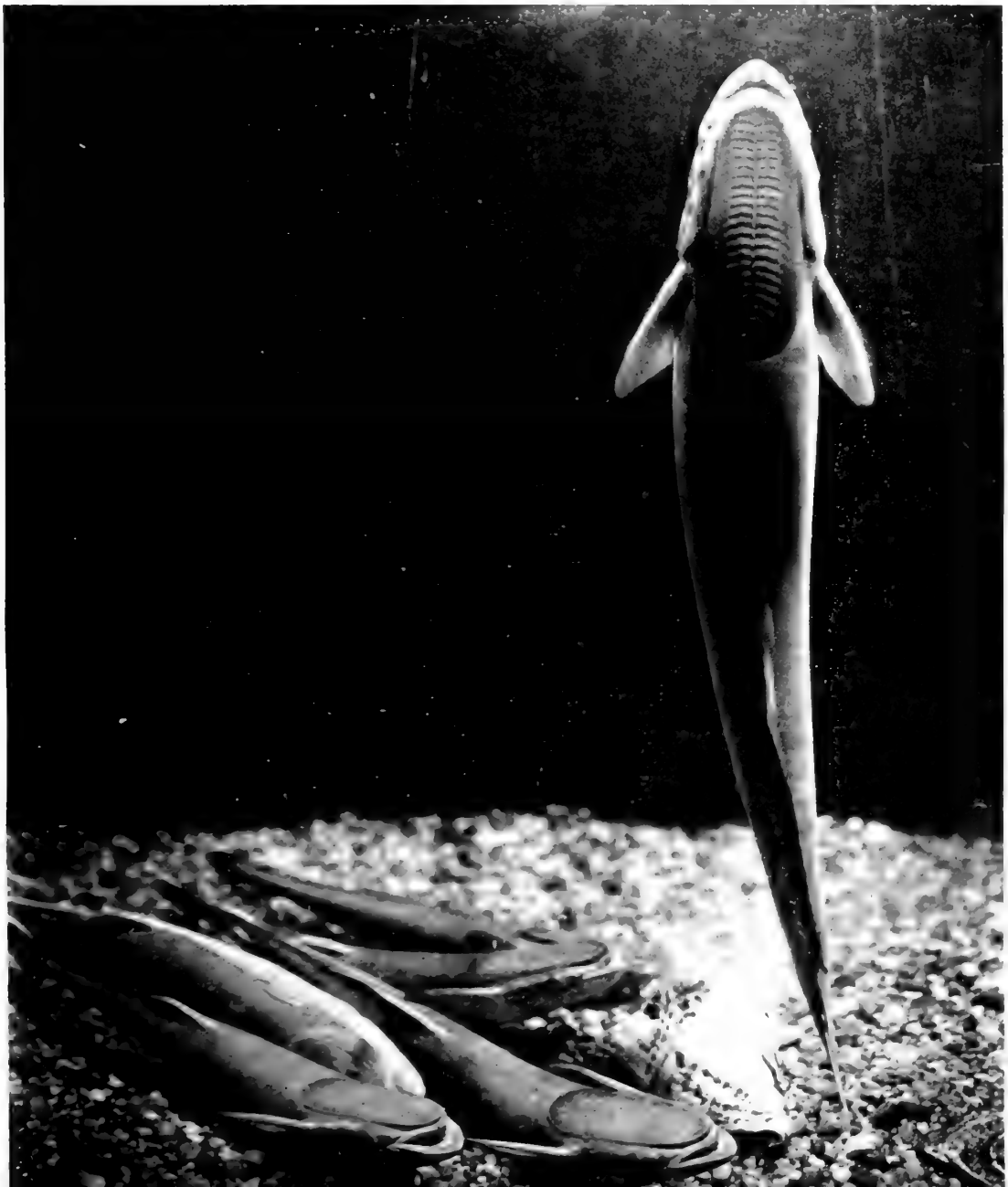
Courtesy N. Y. Zoological Society

↓Remora, showing the sucking disc on top of the head by which it clings to another fish

throat, with which it crushes shellfish. The grinding of these teeth makes a loud grunting sound.

Shark Suckers, etc. (Suborder Discocephali): The Remora, Echeneis, has a suction disc on top of its head, by means of which it clings to the sides of larger fishes, particularly the Sharks.

Angel, Butterfly, and Surf Fishes (Suborder Squamipinnes): The Angelfishes (*Holacanthus, Pomacanthus, Angelichthys*)



and their relatives the Butterfly Fishes (Chaetodontidae) have small nibbling mouths which act as pincers in plucking off small living organisms from the rocks and coral reefs. The great depth of the body and the strength of the fins give the fishes a very firm stance and power in this plucking. Their vivid colors and conspicuous, odd markings are in wide contrast to the usual silver or greenish-blue hue of open sea fishes. In the Butterfly Fishes, the teeth are very fine.

The Surf Fishes (Embiotocidae) are deep-bodied offshoots of the Bass stock. They develop the young within the body of the mother, a very unusual feature among Teleost fishes.

Fighting Fish, Climbing Perch, and Paradise Fishes (Suborder Labyrinthici): These fishes are so called because of the peculiar structure of the pharyngeal bones and respiratory apparatus. In these labyrinth-gilled fishes, the gill filaments discharge their normal function, but in addition, the fourth branchial arch is extremely developed and is provided with thick folds which form chambers where air is retained for respiration.

Betta, the Fighting Fish of Siam, is said to be used by the natives in the same

Angelfishes in a New York Aquarium tank

Courtesy N. Y. Zoological Society

way that cocks are used for cock fights, only in this case the combat is held in a glass aquarium bowl. The various species of this genus are popular as aquarium fishes because of their incredibly varied and beautiful colors.

The Climbing Perch (*Anabas scandens*) has been credited with the ability to climb trees. This is an exaggeration, but the fish is indeed able to move rapidly overland by means of the mobility and the sharp spines of its gill cover, aided by the strong pectoral fins and tail.

The Gouramis (*Osphronemus, Trichogaster, Colisa*) and the Paradise Fish (*Macropodus*) also belong to this order. Almost all of the Paradise Fishes, the Gouramis, and the Bettas build a curious structure known as the "bubble nest." The "bubbles" are small quantities of air taken in the mouth of the fish and liberated at the surface of the water, making a raft several inches across, which is usually attached to a leaf or even to the side of an aquarium tank. The eggs are placed among these bubbles and hatch there.

Channa and *Ophicephalus,* the Snakeheads of Ceylon and China, are closely related and often assigned to the Labyrinthici, although their gill arrangements are not the same as those of the others of the suborder. The gill space, however, may be partly closed by a membrane, and the fish are known to survive long periods of drought.

Sergeant Majors, Beau Gregorys, and Cichlids (Suborder Chromides): The Sergeant Majors are active, bustling little fishes of the coral reefs. The Beau Gregorys and Sergeant Majors are somewhat the same in shape, but the Sergeant Major can be easily distinguished by the conspicuous dark bands across its sides while the Beau Gregory is very often half blue and half bright

Courtesy N. Y. Zoological Society

Butterfly Fishes in a New York Aquarium tank

Courtesy N. Y. Zoological Society

Male Siamese Fighting Fish with its bubble nest

The Sergeant Major

Courtesy N. Y. Zoological Society

Courtesy N. Y. Zoological Society

A South American Cichlid, *Aequidens latifrons*

yellow. Like the Cichlids and the Wrasses, these fishes have crushing teeth in the throat. The Sergeant Major's generic name, *Abudefduf*, comes from two Arabic words, *Abu* meaning "father" and *defduf*, a combined form used in emphasizing the word "flank" or "side"—in other words, prominent sides.

The Cichlids are especially plentiful in Africa, but are also found in brackish and fresh waters of Madagascar, Syria, India, Ceylon, and South and Central America, and as far north as Texas. These fishes provide a fine example of parental care (see page 10). These duties are performed by the females in certain species; in others by the males. But in either case, the eggs are sheltered in the mouth of the parent until the young can take care of themselves. However, the young are not always left

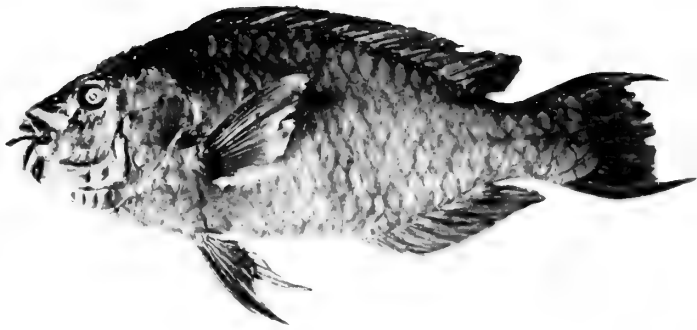
Hogfish: *Lachnolaimus*

Courtesy N. Y. Zoological Society

entirely to their own devices, as the parent fish remains near them and drives off other fishes. Sometimes the male fish does this duty alone, and sometimes the male and female take turns.

Wrasses and Parrot Fishes (Suborder Labroidei): Apparently nature grew reckless when she colored the Wrasses and Parrot Fishes, for these are among the most bizarre sights that bewilder the eye of the visitor to undersea gardens in tropical waters. Only the Cunner and the Tautog, among the northern outliers of the family, have been toned down into sobriety and somberness in the chill waters of New England. The Cunner retains the loose, protruding lips and retreating forehead of its tropical ancestors, but the Tautog has acquired a short, stiff mouth, a prominent chin, and a generally determined countenance.

The Wrasses are more or less omnivorous, nibbling and biting with their strong incisors, and crushing with the remarkable pebble-coated millstones in their throats. In the Parrot Fishes, the front teeth have fused into a large beak, while the mill in the throat is surmounted by cylindrical teeth of oval or flattened section. The origin of this throat apparatus may be traced to the simple conical teeth clustered on the



A.M.N.H. photograph

▲A Parrot Fish, *Scarus caeruleus*

▼The Pudding Wife (*Halichoeres pictus*). These fishes are wrasses. They are easily distinguished from parrot fishes because their front teeth are not fused into a beak

Courtesy N. Y. Zoological Society

surface of the gill skeleton in primitive Wrasses.

The varied colors of the Wrasses and Parrot Fishes are due to the high development of their chromatophores or pigment-bearing organs.

Sculpins, Gurnards, Scorpion Fishes, etc. (Suborder Scorpaenoidei): This group is generally known as the cheek-armored fishes because of the fact that one of the bones surrounding the eye is much enlarged and arches backward over the cheek so as to gain a broad contact with the forepart of the bony gill cover. Thus it forms the so-called "bony stay" that strengthens the skull in this group.

The Gurnards, or Sea Robins, with their broad heads enclosed in this bony shield, bear little resemblance to the Basses, yet they are connected with the primitive Sea Bass stock through the Sculpins and Rosefishes.

Most of the fishes of this group are marine forms, living either among the rocks or on or near the bottom, sometimes at considerable depths. The most primitive forms are the Rosefishes; the most advanced are the Gurnards. The first three rays of the Gurnards' breast fins are specialized as "legs." These rays are separated from the rest of the fin and from each other, and due to this specialization the movements of the fish among seaweed or along any surface much resembles walking on these fins.

In the Lumpfishes and the Sea Snails, the ventral fins are united and form a sucking disk by means of which these clumsy, slow-moving fishes cling to rocks.

The Platycephalids are a group of fishes from the East Indies and Japan. As their name implies, they have flattened heads, which present a curious resemblance to the heads of bottom-living forms of widely different groups, such as the extinct Ostracoderms (see Fossil Fishes, page 82) and the Armored Catfishes (page 38).

The Gobies (Suborder Gobioidei): The Gobies have pushed their way into all the seas outside the Arctic and Antarctic circles, and have representatives in the fresh waters of all parts of the world. The central form, *Gobius*, is not very different from the Johnny Darters of the Perch-Bass group, except that the ventral fins tend to form a sucking disc by means of which the fish can cling to rocks. In the Mudskipper, *Periophthalmus*, the pectoral fins are modified and strengthened so that they can be used as flippers, and the fish skips about on these over the mud flats of eastern tropical rivers. Its eyes are greatly enlarged and protruding.

In the Blind Goby of California, on the other hand, the eyes are reduced to mere vestiges, and the fish lives like a slug under rocks.

In size, the Gobies vary from the minute *Pandaka pygmaea* of the Philippines, which measures only 10 millimeters (less than ½ inch) in length, to *Eleotris marmorata* of Siam, which grows to nearly 3 feet. The Gobies differ from the cheek-armored group in lacking the bony stay of the cheek.

Blennies (Suborder Blennioidei): The Blennies are active little fishes living around rocky or coral reef shores. Certain Blennies, for instance the Lizard Skipper of Samoa, even leap from rock to rock at low water, in this respect paralleling the unrelated Mudskipper. Most of the Blennies are small, but there is one very large marine member of the family. This is the Sea Wolf, *Anarrhichas lupus*. This vicious fish has a long body and strong, tusklike front teeth, and is very hard to handle if caught. It also has large, rounded, crushing teeth on the roof

Courtesy N. Y. Zoological Society

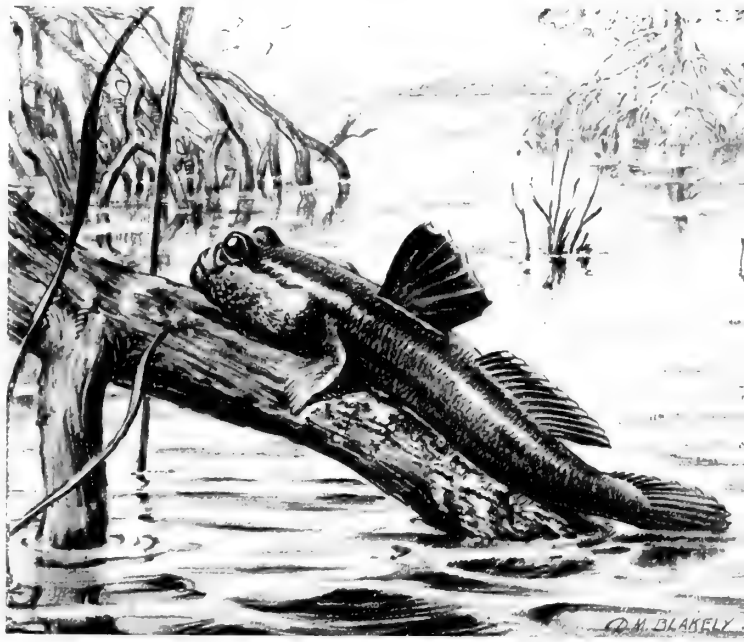
Eighteen-spined Sculpin

of the mouth and inner side of the jaws, enabling it to devour crabs and shelled mollusks.

An outstanding character of the Blennies is the single-spined, small ventral fins. The Eel-pouts (Zoarcidae), elongate derivatives of the Blenny stock, have no spines in any fins except the dorsal.

THE WEAVERS (Suborder Jugulares): The Weavers are distant relatives of the perch-like fishes. Some of them have poisonous spines on the gill covers. The Electric Star-gazer of this group has a pair of powerful electric organs behind the eyes. In this case the electric organs have been derived from some of the muscles that formerly moved the eyeballs.

THE MACKEREL-LIKE FISHES (Suborder Scombriformes): Carangoids (Dolphins, Pompanos, Moonfishes, Jacks, etc.): The central type of these pearly, silvery fishes is the Pompano (*Trachinotus*), from whose narrow, well-rounded body we may derive, on one hand, the much deepened disc of



Drawing by D. Blakely

The Mudskipper (*Periophthalmus*) among mangrove roots: this strange fish skips about over the mudflats of eastern tropical rivers

A Jack (*Caranx hippos caninus*) taken off Talara, Peru, April, 1940

A.M.N.H. Expedition photograph

the Moonfish (*Selene*) and the Lookdown (*Vomer*), and on the other, the progressively elongate form of the Jacks (*Caranx*) and Amberfishes (*Seriola*).

The ornate Roosterfish (*Nematistius*) may be regarded as an Amberfish with an enlarged and plumed first dorsal fin. The Dolphin (*Coryphaena*), a very long-bodied offshoot from the Pompano stock, is famous for its brilliant and changing blue and golden hues. The dolphin of heraldry and sculpture is a composite of this fish and the true dophin, which is a kind of porpoise or toothed whale.

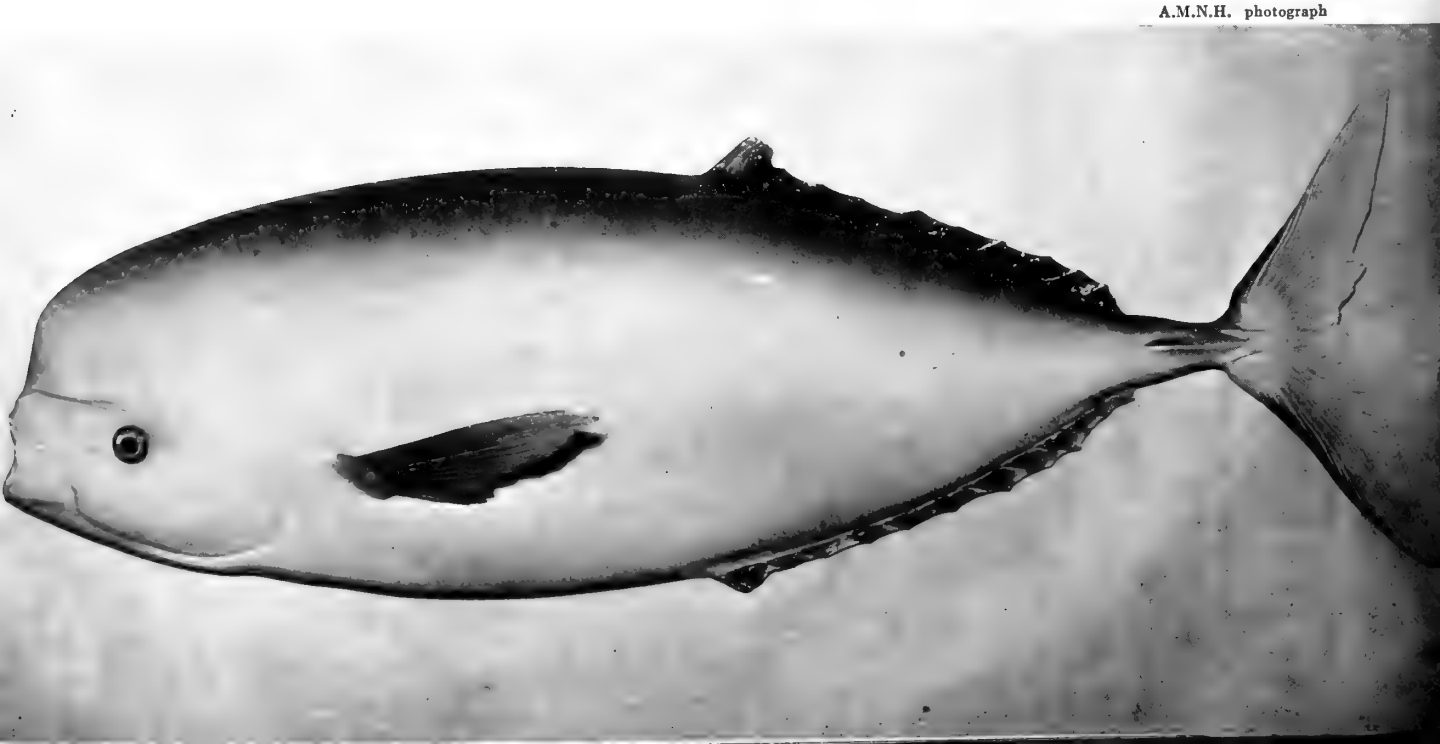
The Louvar (*Luvarus*): Only about 30 specimens of this rare fish have been recorded in the world, and these were chiefly from the Mediterranean and the Atlantic coast of Europe. In 1941, on the American side of the Atlantic one Louvar (represented in the photograph) was taken near East Hampton, New York, and another off Cayo Costa, Florida. From the Pacific Ocean one large Louvar came ashore on the coast of New South Wales, Australia, and two Louvars were taken off the coast of California. The bluish skin of the Louvar is covered with minute mushroom-like scales, which collectively suggest crusted pink snow. In general appearance the Louvar's body somewhat resembles the well-filled contours of the Bonito and Albacore, but it is distinguished by the very small size of its mouth and by the presence of a rounded hump on top of the head, which represents a forward extension of the base of the dorsal fin. The skeleton of the Louvar is extremely delicate and very specialized, but in many features it closely resembles the skeleton of the Albacore (one of the Mackerel group) and in others it recalls the Pompanos and Dolphins.

Mackerels, Tunas, Albacores, etc.: The Mackerel group represents one of the culminating phases in the evolution of the basslike fishes. Its more typical members are distinguished from the latter by the teardrop-shaped body, the delicate, thin boned skull, the absence of spines on the gill covers, the reduction of the scales, the presence of a horizontal keel at the base of the tail, and the symmetrical arrangement of rear fins above and below the horizontal axis.

The acme of speed, of "fineness," and of streamline form is attained by the Mack-

↓*Luvarus*, a large fish that appears to be covered with pink snow, owing to its minute mushroom-like scales

A.M.N.H. photograph



erels, Tunas, Bonitos, and their allies. In the Tunas, Bonitos, and Albacores the body is short and comparatively stiff, the tail large and crescent-shaped, but with a slender, strong base. These fishes often leap from the water like Dolphins. In the Mackerels, the body is more elongate. The Oil Fish, *Ruvettus,* is a deep water relative of the Mackerels. In the Cutlass Fishes (Gempylidae, Trichiuridae), the body has become eel-like, and the tail is reduced to a point.

Spearfish, Sailfish, and Marlins (*see also* Marine Gamefishes, page 75 ff.): The Sailfish *(Istiophorus)* and the Marlins *(Makaira)* are very closely related. The Marlin may be regarded as a Sailfish with a secondarily lowered dorsal fin and reduced ventrals. The Black Marlin of New Zealand, the giant of the family, reaches 14 feet 9 inches in length and 1226 pounds in weight. It is also the most specialized: the pectoral fins tend to be fixed in an extended position, the front end of the dorsal is more emphasized, and the stripes are lost in the generally black color. The vertebrae of the Marlins are greatly elongated and connected by long bladelike forward and backward projections which resist lateral bending and impart great resilience to the backbone.

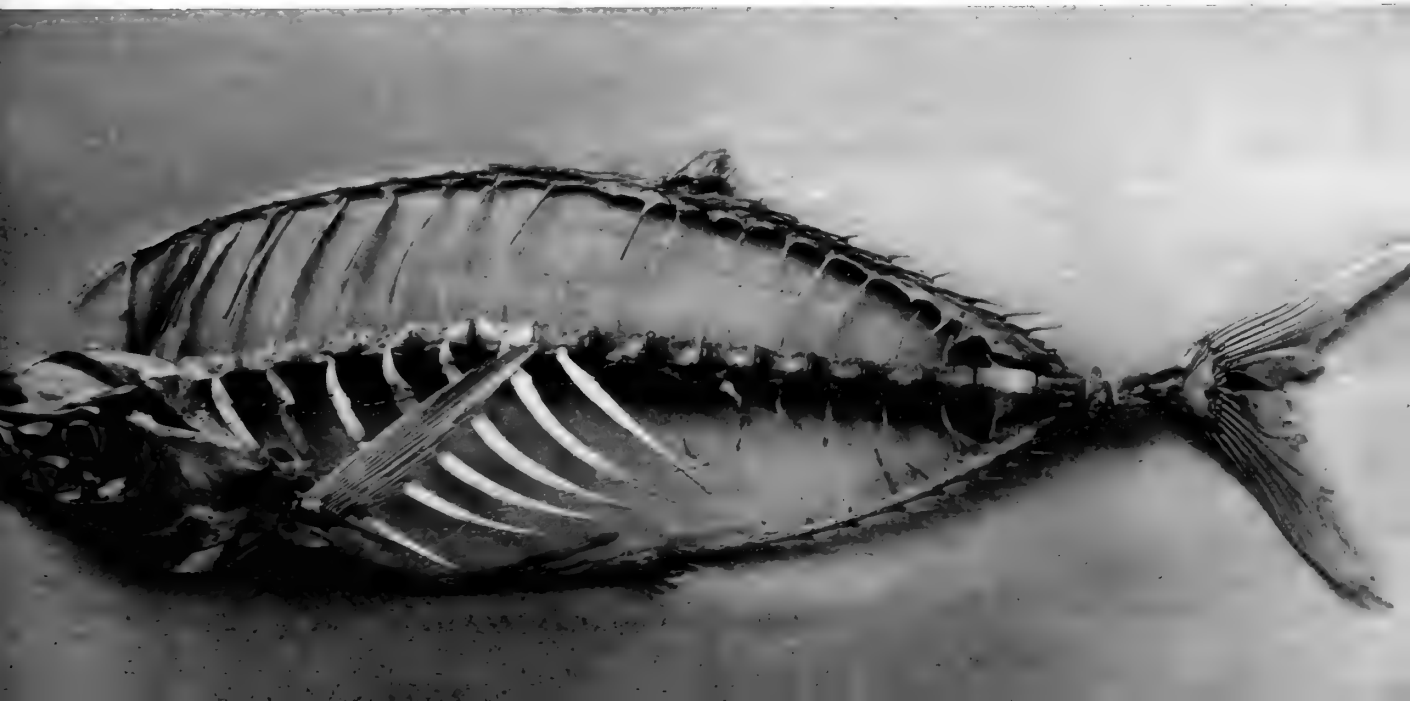
The Spearfish (*Tetrapturus*), a peculiar fish of questionable status, seems to be closely related to the Sailfish and Marlin.

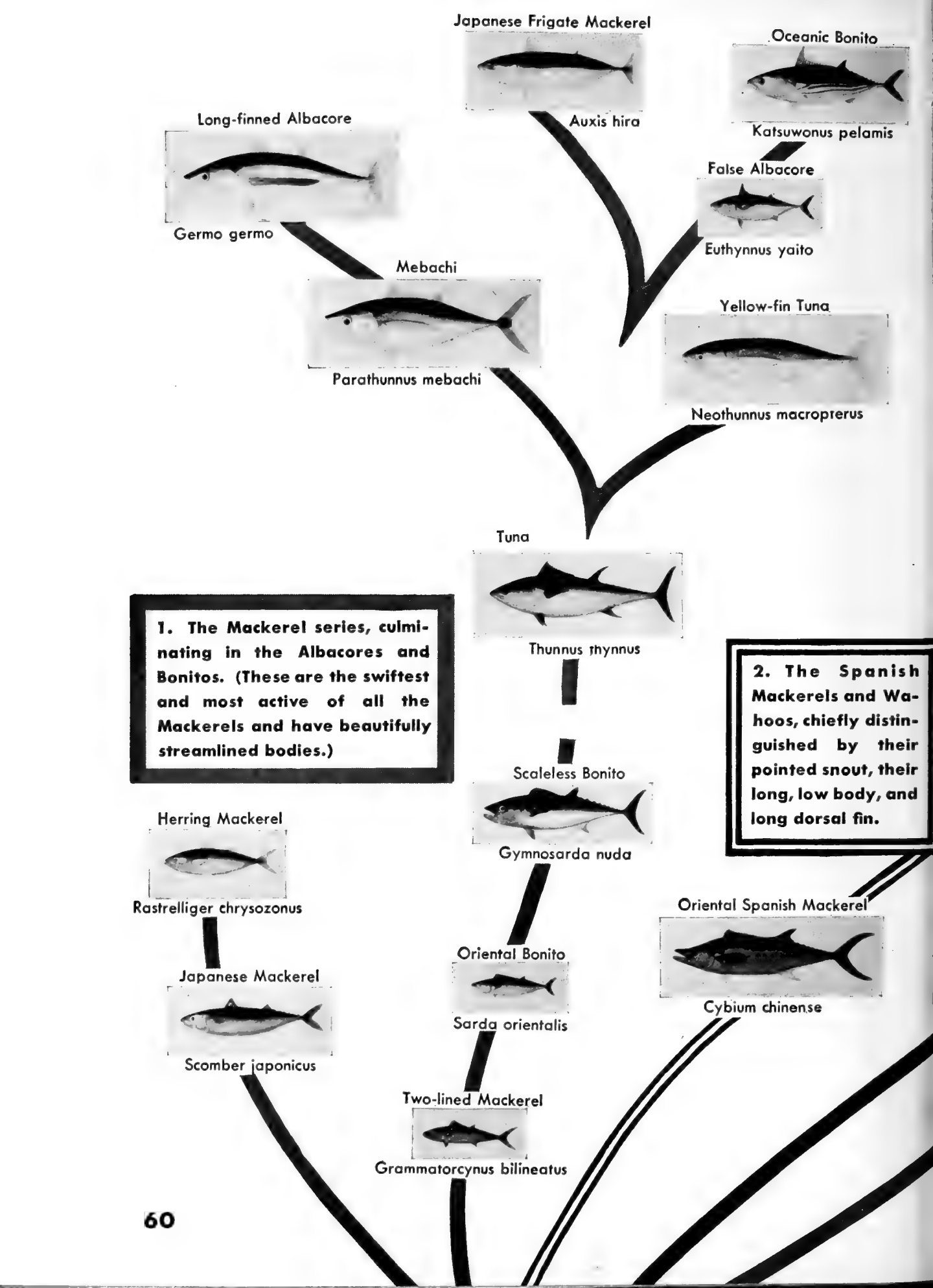
The Swordfish (*Xiphias*): The Sailfish and Marlins, although often called "swordfishes," are widely different from *Xiphias,* the true Swordfish, which is described more fully on page 77. In *Xiphias* the pelvic fins have been completely eliminated and scales are retained only in the young (up to 11 pounds or so), whereas in the Sailfish and Marlin the pelvic fins are present, and long, thorny scales are retained in the adults. The vertebrae of *Xiphias* are short and much less specialized than those of the Marlins.

Acrotus (Suborder Stromateoidei): *Acrotus willoughbyi* is a strange, large fish of which a possible half dozen specimens have been captured, all of them from our Pacific coast. The specimen exhibited in the American Museum of Natural History was caught on hook and line from the Monterey breakwater, in May, 1940. It is related to the Butterfishes (*Poronotus*). Its skeleton has become largely cartilaginous.

The skeleton of *Luvarus* is extremely delicate and specialized

A.M.N.H. photograph



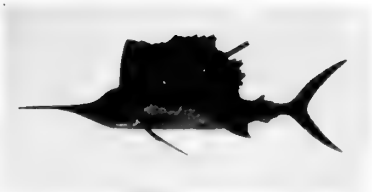

Japanese Frigate Mackerel
Auxis hira
Oceanic Bonito
Katsuwonus pelamis
Long-finned Albacore
Germo germo
False Albacore
Euthynnus yaito
Mebachi
Parathunnus mebachi
Yellow-fin Tuna
Neothunnus macropterus
Tuna
Thunnus thynnus
1. The Mackerel series, culminating in the Albacores and Bonitos. (These are the swiftest and most active of all the Mackerels and have beautifully streamlined bodies.)
2. The Spanish Mackerels and Wahoos, chiefly distinguished by their pointed snout, their long, low body, and long dorsal fin.
Scaleless Bonito
Gymnosarda nuda
Herring Mackerel
Rastrelliger chrysozonus
Oriental Spanish Mackerel
Cybium chinense
Oriental Bonito
Sarda orientalis
Japanese Mackerel
Scomber japonicus
Two-lined Mackerel
Grammatorcynus bilineatus

PEDIGREE OF THE MACKERELS AND THEIR ALLIES

This suborder divides itself into four principal lines

3. The Sailfish and Marlin, in which the forepart of the skull is produced into a long, sharply pointed sword or spear. In the Sailfishes, the dorsal fin is of enormous size. (The True Swordfish [Xiphias] although somewhat resembling the Marlins, forms a very distinct branch [see page 59].)

Sailfish



Istiophorus greyi

Spearfish

Tetrapturus imperator

Swordfish

Xiphias gladius

Cutlass Fish

Trichiurus lepturus

Snake Mackerel

Gempyla serpens

Scabbardfish

Lepidopus caudatus

Wahoo

anthocybium solandri

Domine

Epinnula magistralis

Oilfish or Escolar

Ruvettus pretiosus

4. The Escolar-Cutlass Fish line, which runs out into fierce, eel-like forms.

From an American Museum exhibit

Opahs, Dealfishes, Ribbonfishes (Suborder Allotriognathi):

Opah or Moonfish (*Lampris luna*): This rare visitor on our coasts is a round, iridescent fish with scarlet fins, and reaches a length of 6 feet and a weight of 500 to 600 pounds. The orb of its silvery body suggests the true Moonfish (*Selene*) of the Pompano family, but in the entire construction of its skeleton it differs widely from the Pompanos or any other of the mackerel-like fishes. It seems to be a gigantic relative of *Velifer* and may be remotely related to the Dealfishes (Trachypteridae). These have highly protrusile upper lip-jaws in which the premaxillae slide forward and outward, moving upon sockets in the maxillae.

Dealfishes (Trachypteridae): In these queer creatures the fanlike tail fin is set obliquely to the long axis and is directed upward and backward.

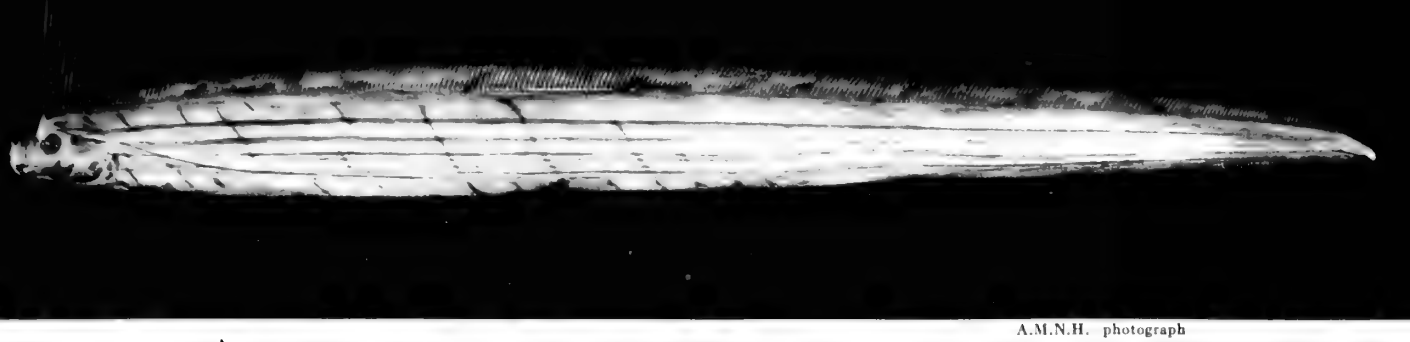
The Oarfish, *Regalecus glesne*, is a specialized Dealfish, strikingly colored. A life-size model is shown in the American Museum's Hall of Fishes. It is sometimes called the Sea Serpent Fish and may have given rise to some of the sea serpent stories.

The fish is very long—it is said to reach a length of 30 feet—but the body is less than 3 inches thick. The body is bluish-silver, and just behind the head rises a high crest of bright scarlet fin rays. The mouth turns sharply upward. As is usually the case in fishes normally living at great depths, the skeleton of this fish is very delicate.

The Oarfish is rarely seen alive but has sometimes been taken when stranded. The one from which the American Museum model was constructed was caught off Otago, New Zealand. The fishermen, thinking it a sea serpent and somewhat alarmed, and also inconvenienced by its length, cut it in several pieces before bringing it ashore.

The Opah, or Moonfish (*Lampris luna*)

A.M.N.H. photograph



A.M.N.H. photograph

The Oarfish (*Regalecus glesne*), a 30-foot fish sometimes called the Sea Serpent Fish. It probably gave rise to some of the tales of sea serpents

ORDER ANACANTHINI
(Cods, Hakes, Grenadiers, etc.)

These are highly specialized offshoots of the spiny-finned order, and in many respects they are degraded forms. Even in the rat-tailed Grenadiers (Macrouridae), deep-sea fishes which are less specialized than the Cods, the true tail fin has been lost and the hind end of the body is prolonged into a trailing wisp. In the Cods and their allies, the tail, while outwardly not unlike that of more normal fishes, appears to be merely an imitation, fashioned from the rear parts of the elongated, subdivided soft dorsal and anal fins, as shown by the structure of the bony rods supporting the tail. In most of the fishes of this order the ventral or pelvic fins are normal, but in the fish known in some regions as the Hake and in others as the Ling (*Phycis*), the ventrals have been reduced to greatly elongate feelers.

The group is essentially marine and ranges from the greatest depths to the shallower waters of the coastal belt.

The abundance of some of these fishes is truly astounding; 19,634,000 pounds of Cod were received in New York City alone in 1943. The roe of a 75-pound Cod contained, according to a careful estimate, no less than 9,100,000 eggs!

Long before the landing of the Pilgrims at Plymouth, boats had come from Europe to the New England coasts and north to the Grand Banks to fish for Cod. These fisheries, which have now developed into a huge industry, were of the utmost economic importance in the life of the early settlers in New England. They center at present in Boston and in Gloucester, Massachusetts. Before the second World War, cod fisheries were also a large industry in France, which sent a famous fleet to the Iceland fishing grounds, and in Norway, which carried on big fisheries in the Lofoten Islands.

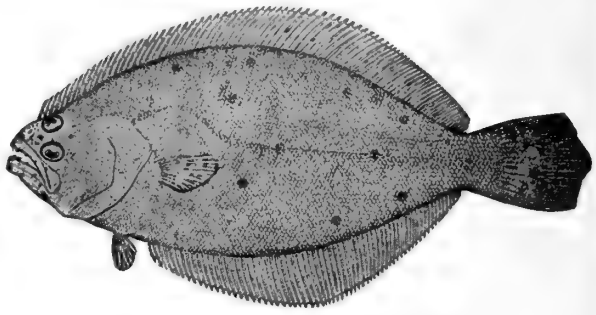
Cod: an abundant and commercially important fish. A 75-pound cod can lay over nine million eggs

Courtesy N. Y. Zoological Society

ORDER HETEOSOMATA
(Flatfishes)

In this group belong the Flounder, Halibut, Turbot, etc.—fishes which habitually lie on one side on sandy bottoms. They have been derived from deep-bodied fishes not unlike the John Dory (*Zeus faber*). The fossil fish, *Amphistium*, of the upper Eocene period, which has been regarded as an early member of the Flatfish order, was a deep-bodied, symmetrically built form which had not yet become twisted for lying on its side.

Migration of the Eye in Flatfishes: When the Flatfishes are hatched, the young are normal in appearance, with even coloration and an eye on either side. They swim in a normal way. However, as the fish begins to develop, it tilts over toward one side, and finally becomes adapted for resting and swimming in this position. Meanwhile the color on the more exposed side grows deeper, while that on the under side remains light. The eye of the down-turned side migrates over the top of the skull so that, in the adult, both eyes lie on the upper side of the head. In most of the Flounders, the eyes and color are on the right side; in the Turbots, on the left. The mouth also is partly twisted onto the upper surface.

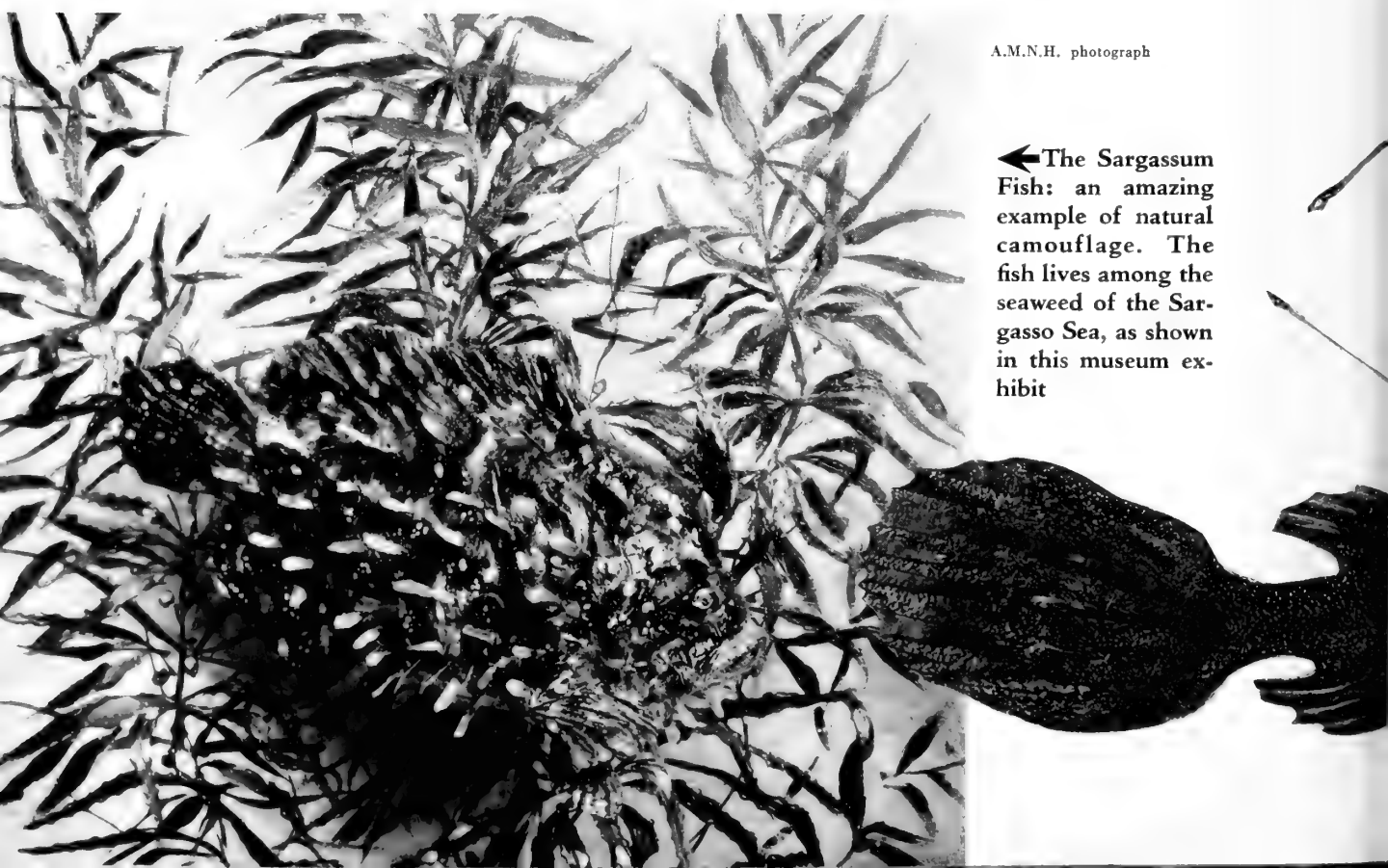


After Jordan and Evermann, 1900

↑Northern Fluke (*Paralichthys dentatus*). Its eyes are on either side of its head in youth, but as in other flatfishes, one of them migrates as the fish grows until they are both on the top side

ORDER PEDICULATI
(Frogfishes, Batfishes, Anglers)

The Frogfishes (Antennariidae) are small, active fishes, the best known of which



A.M.N.H. photograph

←The Sargassum Fish: an amazing example of natural camouflage. The fish lives among the seaweed of the Sargasso Sea, as shown in this museum exhibit

is probably the Sargassum Fish, *Histrio histrio*. Its shape and color make it very difficult to distinguish from the masses of weed in which it moves about. Like the other fishes of this order, it has a peculiar joint at the base of the pectoral fins. The front part of the dorsal fin is prolonged on top of the head above the upturned mouth; and one of the fin rays, which looks like a slender fishing rod, can be moved by small muscles at its base. The tip bears a bit of the fin web and serves as a bait or lure for the small crustaceans on which the Frogfish feeds.

The terrible living trap set by the Anglerfish (*Lophius*) lies in wait for the unwary fish that stops to examine its dangling bait. This trap consists of the sharp-toothed jaws and cavernous interior of its enormous mouth, and just as in the Frogfishes, the bait is a bit of skin floating from the top of a movable fishing rod—an enlarged and separated ray of the dorsal fin.

In the Oceanic Deep-Sea Anglers (Ceratiidae), which live in abyssal darkness, the lure or "bait" is supplied with a luminous substance (luciferin).

The males in several species of Oceanic Anglers are of extremely small size and live dangling like pendants from the side of the head of the gigantic females. The American Museum exhibit shows the replica of a cast in the British Museum (Natural History) of *Ceratias holboelli*, the Oceanic Angler, with its parasitic male. We quote from the original British Museum label:

"The female Angler Fish with attached parasitic male from which the original cast was made, was taken near Iceland. It is 40 inches long and has a male 4 inches long attached in the mid-ventral line a little behind the head. Unlike the female, the male has no fin ray on the head; its mouth is small, toothless and closed in front, and the alimentary canal is vestigial. Fleshy outgrowths from the face of the male unite in front of the mouth and face with a projection from the skin of the female. Dissection reveals that both the outgrowth from the male and the projection from the female are formed of fibrous tissue with numerous small blood vessels. The union is complete so that it is impossible to say where one fish begins and the other ends. The blood system appears to be continuous with that of the female, from which the male derives its nourishment. The Ceratioids are unique among backboned animals in having dwarfed males of this kind."

The habits and conditions of life of the Ceratioids—few in number, solitary, slow swimmers, floating about in the darkness of the middle depths of the ocean—would make it difficult for a mature fish to find a mate. It is possible that the males, as soon as they are hatched, at which time they are relatively numerous, are attracted by the females' luminous "bait" and if they find one, become attached to her and remain attached for life. Probably the male first nips a piece of skin of the female, and then its lips fuse with the papillae so formed.

The Oceanic Angler (*Ceratias*), with the parasitic male attached on the lower edge, behind the head

Lilo Hess photograph

THE BATFISHES (Ogcocephalidae) are small, very much widened relatives of the Frogfishes. *Ogcocephalus vespertilio* occurs from the West Indies to Florida and is occasionally found as far north as New York. It has an elongated, narrow, and rather pointed "snout," which is really not a snout but a forwardly grown hump projecting above and in front of the vestigial "bait." The pectoral fins are greatly enlarged and project forward and outward like frogs' legs. The pelvic fins, although smaller, are also leglike. They are fastened to the underside of the huge pectoral girdle in front of the pectoral fins. Presumably these strange fishes can hop along the bottom of the ocean and can also swim by flapping their pectoral fins. The Batfishes are clearly connected with the Frogfishes by the deep-sea fish *Chaunax*. In this fish the bait or line is already enclosed by the overgrown dorsal hump, which is the greatly enlarged spine of the front portion of the dorsal fin, but the rest of the body is more like that of the Frogfishes.

THE ANGLER group may be regarded as excessively specialized relatives of the Blennies (page 56).

A family of depressed, scaleless bottom fish, known as the Toadfishes (Batrachoididae) is in some respects intermediate between the Blennies and the Anglers.

ORDER PLECTOGNATHI
(Surgeons, Triggerfishes, Puffers, etc.)

THE SURGEONFISHES (Acanthuridae) are so called because they carry sharp knifelike spines one on either side of the tail base. These spines are actually greatly enlarged scales. They are sometimes depressible in a groove. The fish seems to be able to give a vicious sideswipe with its tail. In *Xesurus*, a Pacific fish, the knife is replaced by three or more forwardly directed spikes. The very small but strong jaws are armed with nibbling teeth and set at the end of a downwardly produced muzzle. The Surgeonfishes are a specialized offshoot of the basslike fishes (Percoids). They may be remotely related also to the Angelfishes (Pomacanthidae) and the Butterfly Fishes

If a larger fish tries to swallow it, the Triggerfish can lock the large spike behind the eye in an erect position. It does this by pulling the small one just back of it into place

Surgeonfish, showing horizontal knifelike spine on the stem of the tail

Photographs courtesy N. Y. Zoological Society

Courtesy N. Y. Zoological Society

The Puffer inflated and deflated. It pumps itself full of water as a method of defense. Both photographs are of living fishes in the New York Aquarium

(Chaetodontidae) and more nearly related to the Moorish Idols (Zanclidae) and the Triggerfishes (Balistidae).

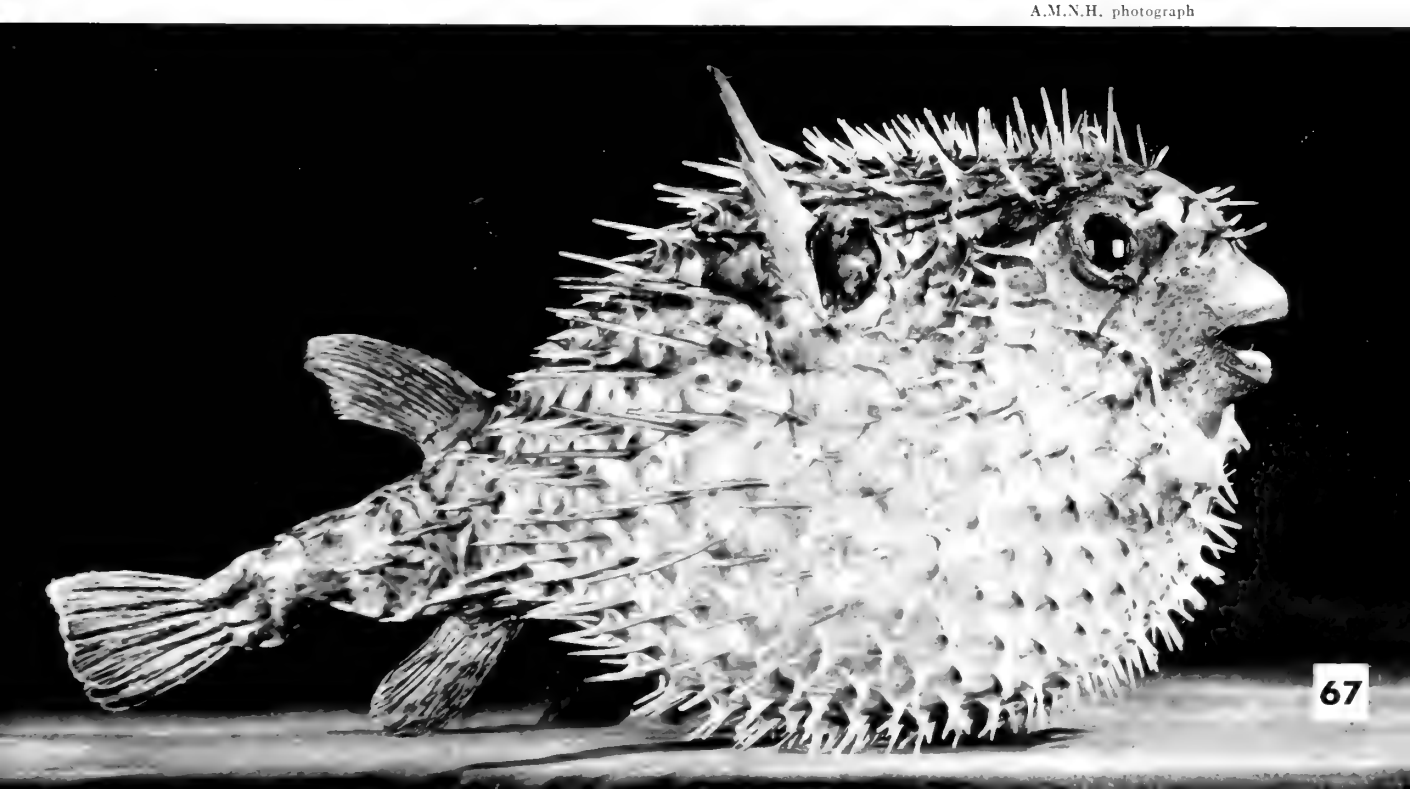
THE TRIGGERFISHES (Balistidae): The Triggerfish is an inoffensive fish which swims around coral reefs searching for something good to nibble. If a large fish attempts to swallow him, he erects the tall spike or "trigger" on his back, stretches his leathery skin and awaits developments. The real trigger is a small spike, behind the larger one. When it is pulled into place by the muscles beneath, it serves to lock the large spike in an erect position so that it cannot be lowered until the "trigger" is withdrawn. The Queen Triggerfish, *Balistes vetula,* one of the larger Triggerfishes, is common about Florida and the Bahamas. It is very brilliantly colored and capable of considerable and rapid color change. The Triggerfishes are more specialized relatives of the Surgeonfishes.

THE FILEFISHES (Monacanthidae) are closely related to the Triggerfishes, but they have only a single spine on the back and lack the trigger arrangement of the Balistidae.

THE TRUNKFISHES (Ostraciidae) are en-

The Porcupinefish (*Diodon hystrix*) adds bristling spines to its inflationary defense

A.M.N.H. photograph

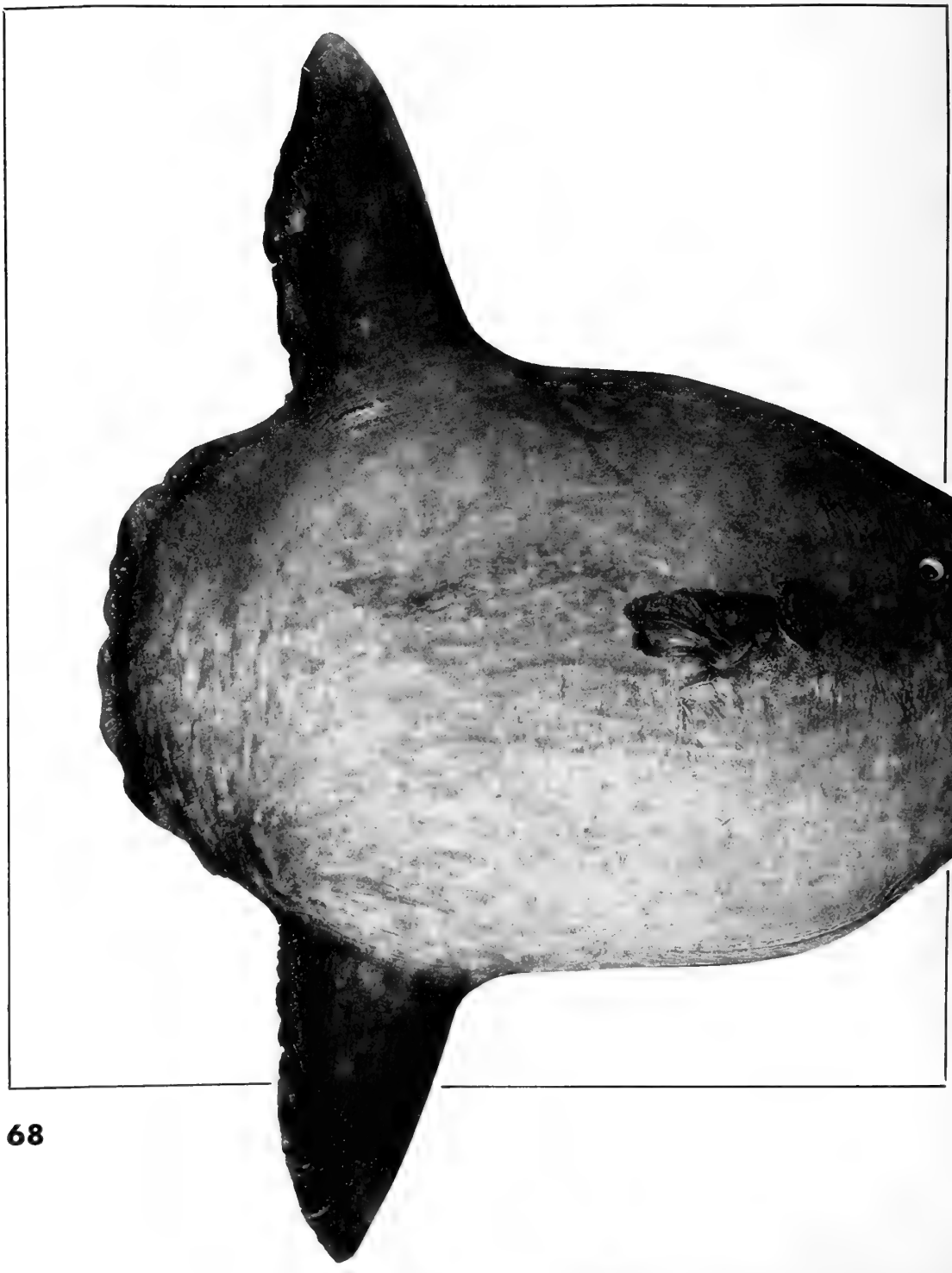


cased in a solid shell of derm-bones. They are incapable of any body movement except in the fins. Even the root of the tail is enclosed in its own bony tube.

THE PUFFERS AND PORCUPINEFISHES: The frog that tried to swell to the size of an ox finds a certain parallel in the Puffers (Tetraodontidae) and Porcupinefishes

A 2000-pound Ocean Sunfish (*Mola mola*) in the Zane Grey Gamefish Collection at the American Museum of Natural History

A.M.N.H. photograph



(Diodontidae). Unlike the frog, however, they do not burst, but readily deflate themselves before their elastic limit is reached. They puff themselves out by pumping water in through the mouth by the action of certain specialized throat muscles. Apparently it is as hard for a larger fish to bite an inflated Puffer as it is for a boy to bite an apple floating in the water.

In both Puffers and Porcupinefishes, the front part of the jaw is modified into powerful nippers for biting and crushing resistant objects. In the Puffers, the right and left sides of the beaks are separated; in the Porcupinefishes they are fused.

The Ocean Sunfish (*Mola*)[1] is a gigantic relative of the Porcupinefish. Its body is enveloped in rubbery skin from 2 to 2½ inches thick. Bending of the body is therefore limited. Movement is largely confined to side-to-side waving of the high median fins and gentle undulations of the scalloped border of the tail, which serves also as a rudder. Lateral stability is aided by the wide, more or less truncate, pectoral fins.

The most striking characteristic of the skeleton is the great reduction of bony tissue. Ossification is so weak that the material when cut with a knife resembles cartilage. The brain is extremely small for the size of the skull and brain cavity.

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[1] Gregory, W. K., and H. C. Raven: Notes on the Anatomy and Relationships of the Ocean Sunfish (*Mola mola*). *Copeia*, 1934, no. 4, pp. 145-151, 1 pl.

Deep-Sea Fishes

Netting operations on the "Arcturus." In 1925, the Arcturus Expedition sent out by the New York Zoological Society, collected numerous specimens of the incredibly fragile fishes that live in the depths of the ocean a mile or more beneath the surface. Every square inch of their bodies at that depth is exposed to a water pressure of over a ton.

The American Museum's exhibit contains some of the actual specimens, and also a series of deep-sea groups, material for which was gathered near the Galápagos Islands

Courtesy N. Y. Zoological Society

Wandering Ghosts in the Country of Perpetual Night. These two groups show the ocean floor, 1000 fathoms down, where deep-sea fishes wander about

bleached skeleton of a whale. In this realm of total kness, the water pressure is over a ton and the perature around freezing

A.M.N.H. photographs

Little Sea Devils. These are some of the small Oceanic Anglers. Their mouths are open to catch the prey attracted by the bit of luminous skin at the end of their fishing-rod appendages

←The Bathysphere. This steel sphere was first used by Dr. Beebe off Nonsuch Island, Bermuda, in the summer of 1930. It is so made and equipped that two investigators have descended in it to over 2200 feet below the surface of the sea, to observe the life in those depths through its fused quartz windows

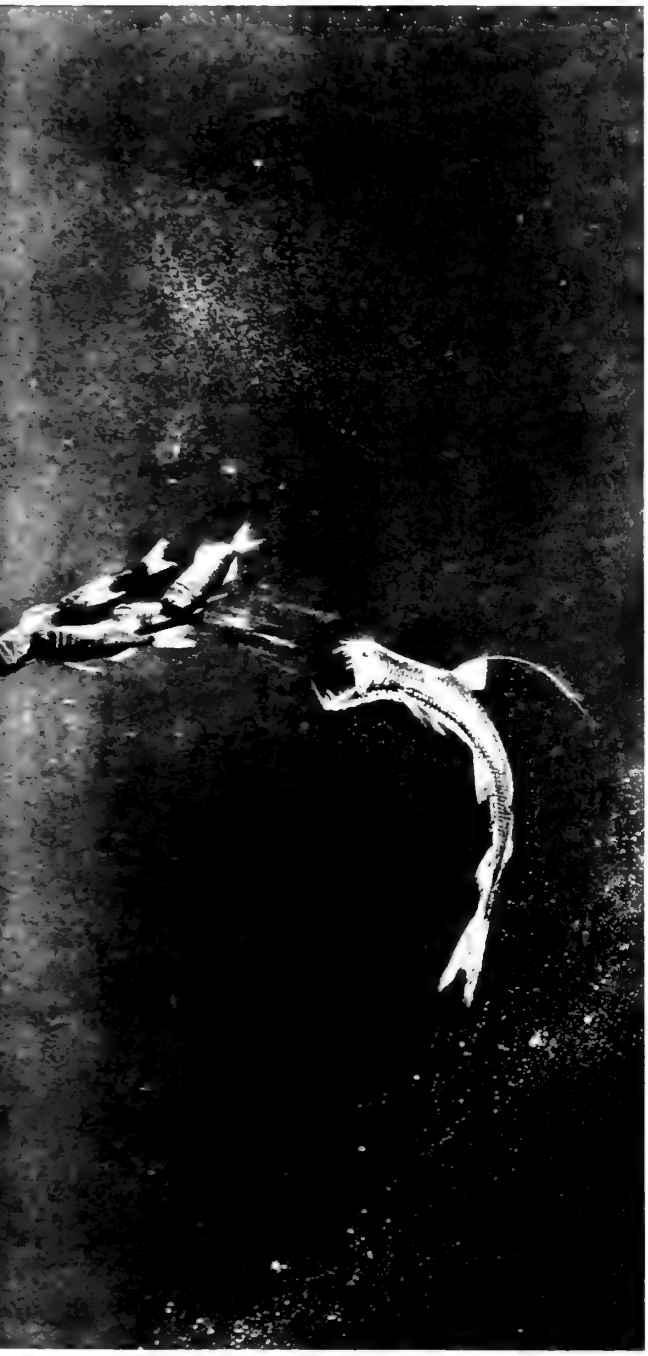
↓The Black Pirates. These degraded Eels have lost almost everything but their voracious appetites, for which their enormous mouths and elastic stomachs are well equipped. One of them has just swallowed a fish larger than himself

A.M.N.H. photographs

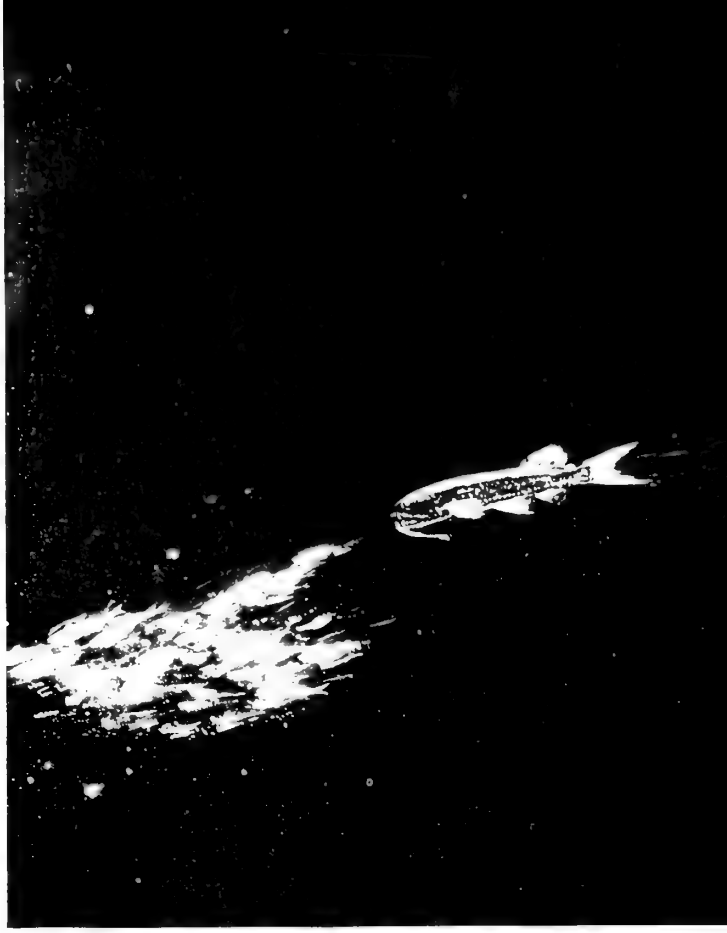
Luminous Fishes

"The Dragon Strikes": A group of Big Heads being pursued by the gleaming, iridescent Dragonfish, *Chauliodus*

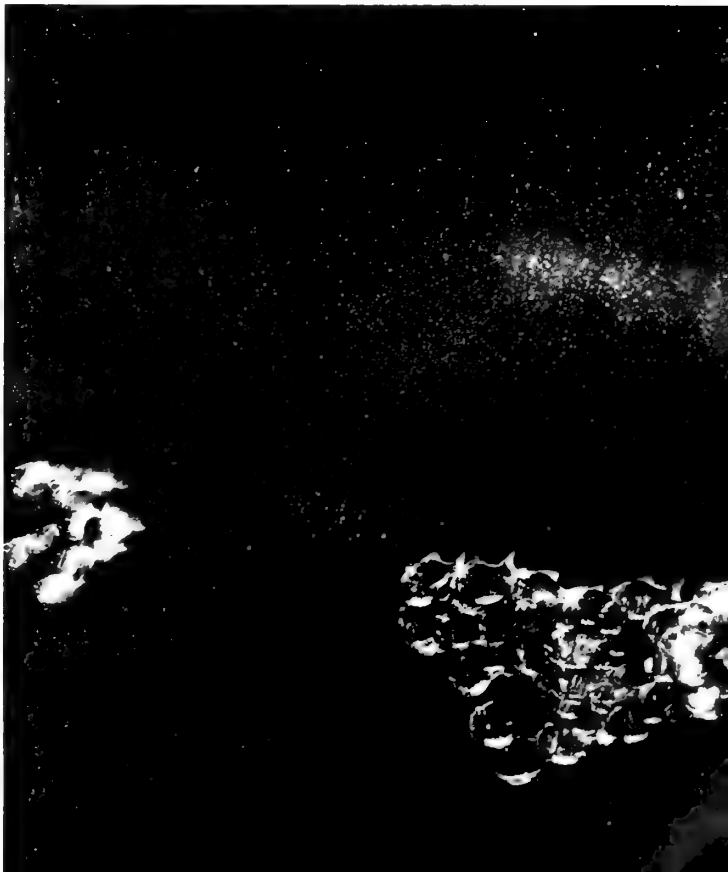
A.M.N.H. photographs



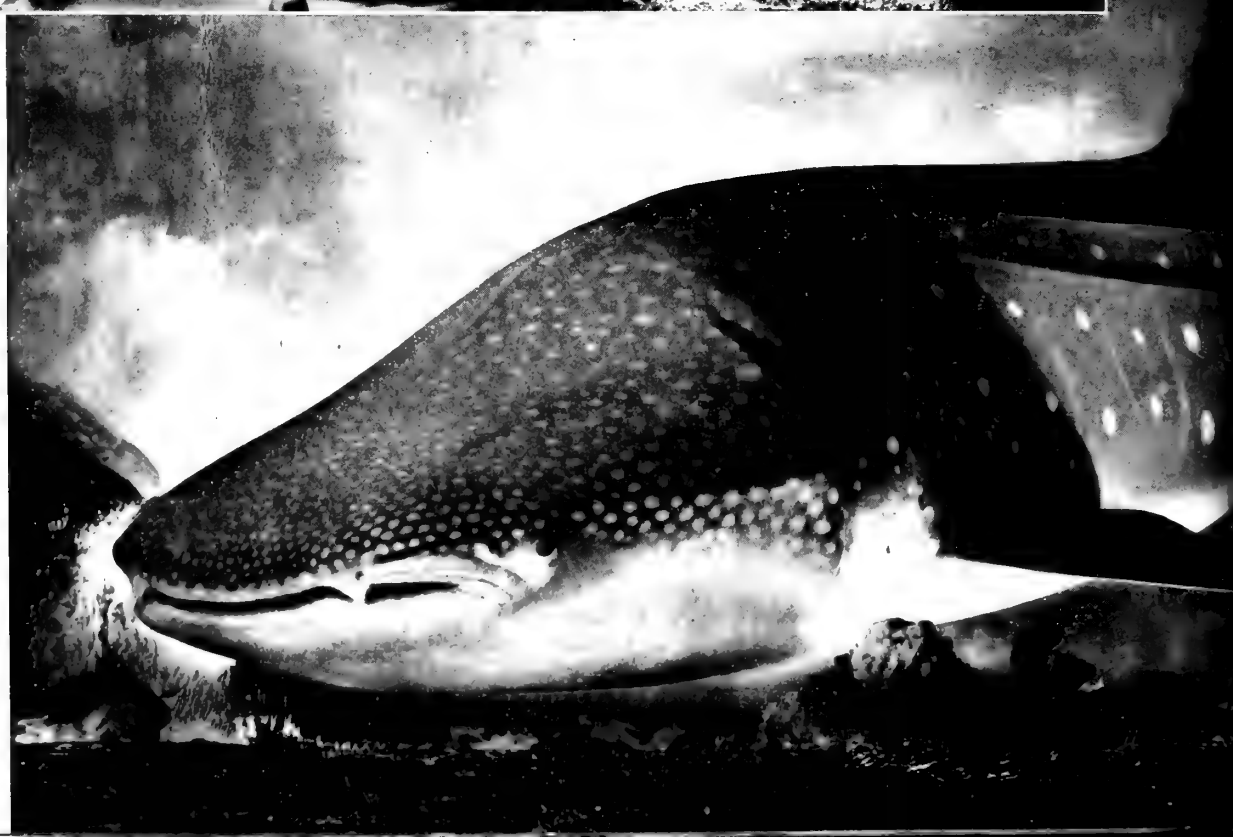
"Blazing Jewels." The Jewelfishes (Myctophids), flashing and luminous, live far down where the last feeble light merges into blackness



"Neptune's Fireflies": Lanternfishes, with rows of phosphorescent spots sparkling on their sides, pursued by *Astronesthes*



A.M.N.H. photographs



Reef Fishes

←The Great Barrier Reef. The northeast coast of Queensland, Australia, is bordered for more than 1000 miles by a chain of coral islands, lagoons, and reefs. At the southern end of the Barrier lies Heron Island, where the material for this group at the American Museum was collected. The generally flat top of the coral banks is determined by the low tide level, since the coral animals die if exposed long to the air.

The branching and massive corals afford shelter and subsistence to a rich fauna of crustaceans and the small, brightly colored fishes who feed upon them

↙ A Whale Shark propels its huge checkerboard body towards us in the American Museum's exhibit of the waters off Bimini. This small island at the northern end of the Bahamas is almost level with the ocean. Where the shallow sandy bottom deepens to form pools, Blueheads, Sergeant Majors, and Demoiselles dart in and out among coral caverns. Grunts, Queen Triggers, and an occasional Barracuda swim about among the purple Sea Fans; and a dark Sting Ray may sometimes be seen lying half-buried in the sand.

Bimini is within five miles of the Gulf Stream and a short distance from the deep submarine valley known as the Tongue of the Ocean

Marine Game Fishes

↓Zane Grey with a 1036-pound Tiger Shark caught in Australia. To Zane Grey we are indebted for the nucleus of the American Museum's Game Fish Exhibit which originally consisted of Dr. Grey's own rod and reel catches. These are now shown in a separate section of the Game Fish Exhibit

↑Michael Lerner with two rod and reel catches taken off Tocopilla, Chile, on the Michael Lerner American Museum Chile-Peru Expedition of 1940. The Striped Marlin (*left*) weighed 410 pounds, and the Swordfish 608 pounds. Both fishes occur in great numbers off the northwest coast of South America. Mr. Lerner is the donor of the Mako Shark, Tuna, and Blue Marlin groups shown in this section

Habits and Life History of the Swordfish

The International Game Fish Association has installed in the Game Fish Section of the American Museum's Hall of Fishes an exhibit illustrating the life history of this fish, from the tiny egg to the huge adult.

The Swordfish may be readily distinguished from the Marlin by the absence of pelvic fins and, in the adult, the absence of scales. Swordfish that have been hooked or harpooned sometimes follow the line back and dash themselves at the boat, occasionally piercing the wood with their sword. One of these fishes has been known to penetrate an 18½ inch plank, 14½ inches of which was oak.

Commercial fishing for Swordfish is carried on both for the very palatable flesh and for the high vitamin content of the oil from its liver.

There are also commercial marlin fisheries in some parts of the world, although the flesh is generally considered edible only if smoked. The Striped, Black, and Silver Marlins frequent the Pacific; the White and Blue are limited to the Atlantic.

The Sailfish. This very beautiful exhibit, presented to the American Museum by Mr. and Mrs. Keith Spalding, represents a hooked Pacific Sailfish clearing the water off the rocks of Cape San Lucas, Lower California

A.M.N.H. photograph

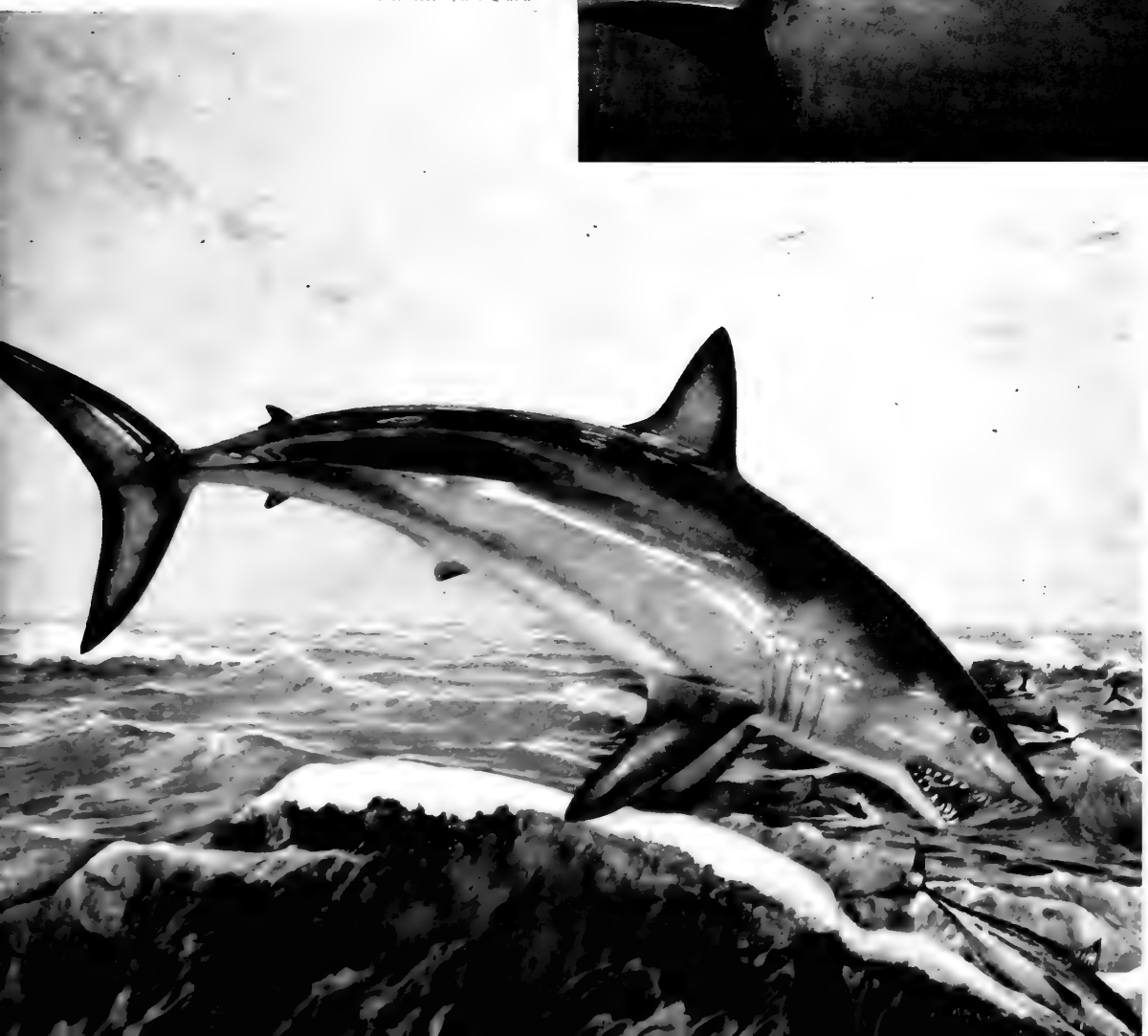
The Blue Marlin, one of the Atlantic Marlins: a specimen taken on an American Museum expedition in the cobalt waters of the Gulf Stream off Bimini, Bahama Islands

A.M.N.H. photograph

➔A Bluefin Tuna. One of the favorite fishing grounds for this fish, both commercially and for sport, is off Wedgeport, Nova Scotia, where this specimen, exhibited in the American Museum's Tuna Group, was taken

➘The Mako Shark is one of the most highly prized of all hard-fighting game fishes. The specimen shown here weighed 602 pounds. The Mako is probably the swiftest of all sharks, and its spectacular leaps are said to reach as high as the masthead of a launch

A.M.N.H. photographs



OUTLINE OF FISH HISTORY

After W. K. Gregory

Fossil Fishes

The Bashford Dean Memorial Exhibit

Bashford Dean (1867-1928), the founder and first curator of the American Museum's Department of Fishes, was one of the great leaders in the study of fossil fishes and of the development of recent fishes.

This exhibit is based on a selection from a small part of the Museum's extensive collections of fossil fishes. It includes among others, (1) fishes of Devonian and Carboniferous ages, which came to the Museum through Dr. Dean's friend and teacher, Dr. John Strong Newberry, (2) fossil fishes of Upper Cretaceous age from Mt. Lebanon, Syria, and (3) huge fishes from the chalk formations of Kansas.

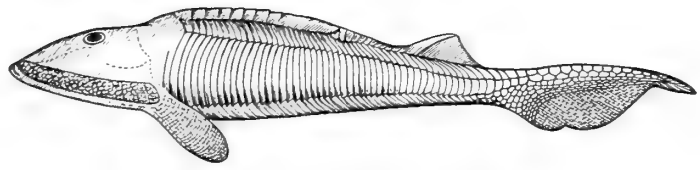
The inconceivably vast stretch of time suggested by the adjacent chart, "Outline of Fish History," may at first baffle the imagination. Our first reaction to such data is the question "How are such stupendous figures of geologic time computed?"

The answer, in detail, is contained in a volume entitled "The Age of the Earth," prepared under the auspices of the National Research Council. This volume contains a description of methods employed by physicists in measuring the ages of rocks containing pitchblende (uranium) and other radioactive substances giving off radium rays and other forms of radiant energy. No matter what degrees of heat or pressure are applied in the laboratory, these rocks continue to emit radiant energy according to their original rates.

Briefly stated, pitchblende gives off radium rays and other radiations in a slowly descending series, extending over immense periods of time. The residue, which has lost its radiating power, is lead. The mass of the lead, when measured, becomes a factor in a formula for measuring the age of the rock. The radium-bearing rocks have welled up from great depths and solidified at various levels in the entire series from older to younger rocks. Their computed ages range from about 1½ billion years down to 37 million years or less.

The Oldest Known Vertebrates

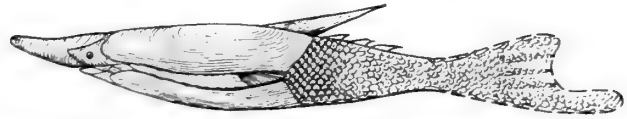
The Cephalaspids had shieldlike heads and were probably slow-moving, bottom-living forms



A Hemicyclaspis (After Stensiö)

B Anglaspis (After Kiaer)

The Pteraspids were more fishlike and swift-swimming than the Cephalaspids



Pteraspis (A composite from Powrie & Lankester, and E. I. White)

The Anaspids were elongate, somewhat herringlike forms

D Pharyngolepis (After Kiaer)

The Oldest Known Fossils

(THE OSTRACODERMS)

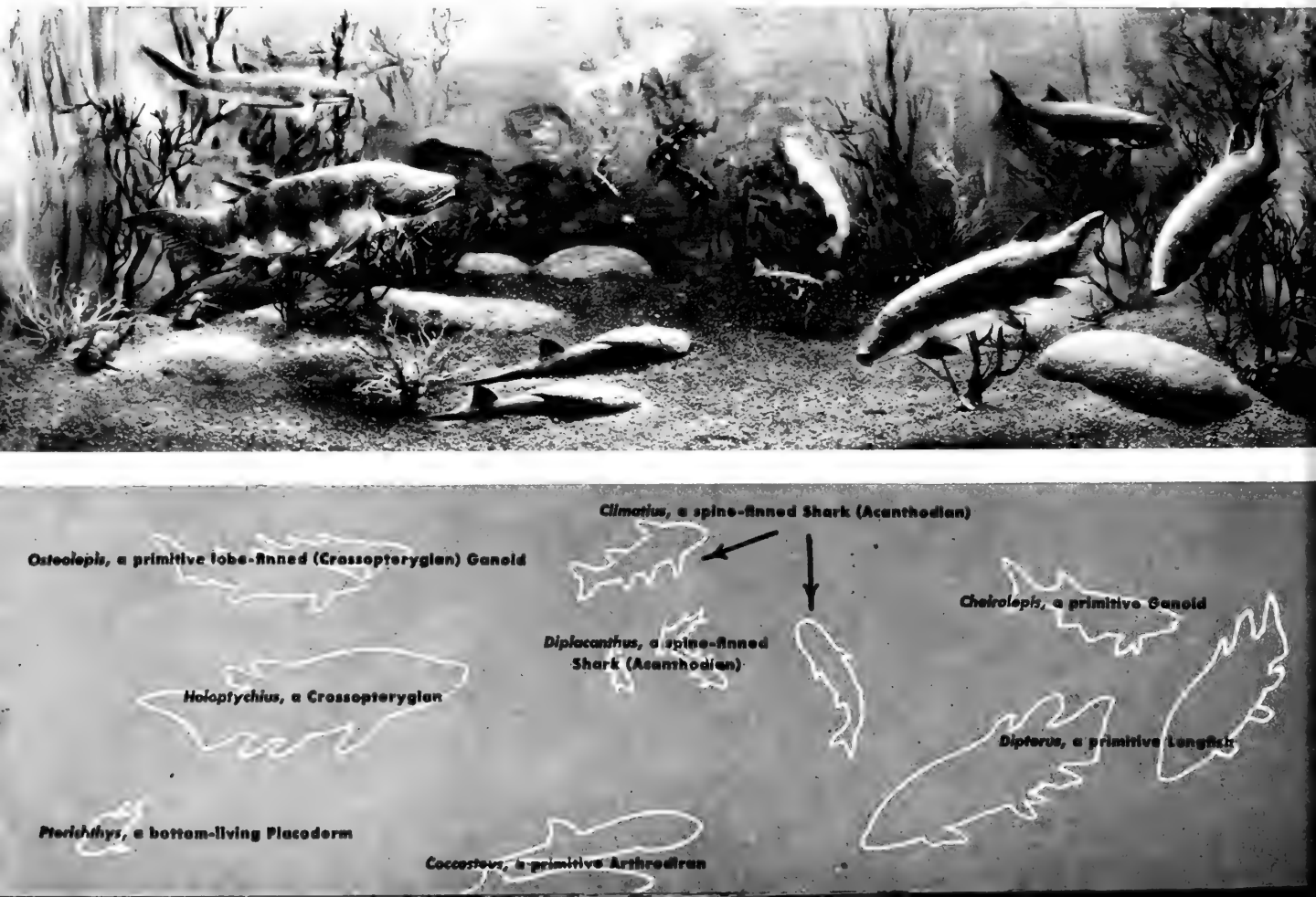
The oldest known fossilized remains of fishes have been found in rocks of Ordovician age, estimated to be more than 400 million years old.

These primitive fishes were already built upon the same basal plan that is seen in all the hosts of later vertebrates. That is, their brain and nerve tubes were located on the upper or dorsal part; beneath this was a long elastic tube, the notochord, and beneath the latter a digestive tube. Thus they were profoundly different from worms, crustaceans, scorpions, and insects, in all of which the nerve tube is on the side next to the ground. These earliest chordates are called Ostracoderms, meaning "shell-skins," because their heads and chests are covered with a shell, or shield, composed of a hard skeletal substance related to dentine. As compared with later fishes, most of the Ostracoderms were probably rather sluggish, clinging to the rocks or resting on the bottom, sucking in small floating food particles by a pumping action of the throat. Their "jaws" were at most simple pincer knobs around the mouth, and they seem to have lacked the cartilaginous bars that form the jaws of Sharks. Hence they are often called Agnatha ("jawless").

In one order of Ostracoderms, the Heterostraci, typified by *Pteraspis* ("wing shield"), no bone cells were present in the shield, which was composed of five main plates. In the second order, Osteostraci, bone cells were well developed, the head shield was continuous, and the large eyes were on top of the head. In a third group, Thelodonti, the shield was represented by numerous small plates or denticles, and the fore part

"The Fossil Aquarium": a restoration of early fishes from the Old Red Sandstone of Cromarty, Scotland

Restorations by Dean, Hussakof, and Horter, partly after Traquair; background by C. R. Knight



of the body was rounded and flattened. In a fourth group, Anaspida, the general form was more typically fishlike, and a more active, almost predatory, life is indicated.

Some of the Ostracoderms have the characters that would be expected in the remote ancestors of the existing Lampreys and Hagfishes, or Raspmouths (see page 16), although the fossil connecting links have not yet been found. In the larval stage of the Lamprey, the arrangement of the mouth, brain, and gills is remarkably like that of the Ostracoderms.

The Fossil Aquarium

The "fossil aquarium" represents some of the leading fish types that flourished in the ages preceding the appearance of cold-blooded, land-living animals. All the fishes shown were found in a single locality and in a single layer of Old Red Sandstone (mid-Devonian). In their coloring, they have been made to correspond with their nearest living relatives.

The world of fishes as it was in Devonian times was already many millions of years old. Some of its older races, for example the Acanthodians (Nos. 3, 4, 6) and Arthrodires (No. 5), were already long past their prime. On the other hand, there were then comparatively young and rising groups, such as the Lobe-Fins (Nos. 1, 2) and Lungfishes (Nos. 8, 9), which were destined to become more numerous and diversified and then to dwindle toward extinction. Finally, there were the true Ganoids (No. 7), the ancestors and forerunners of the countless hosts of Teleost fishes, which for at least the past 80 million years have swarmed in all the seas and fresh waters of the earth.

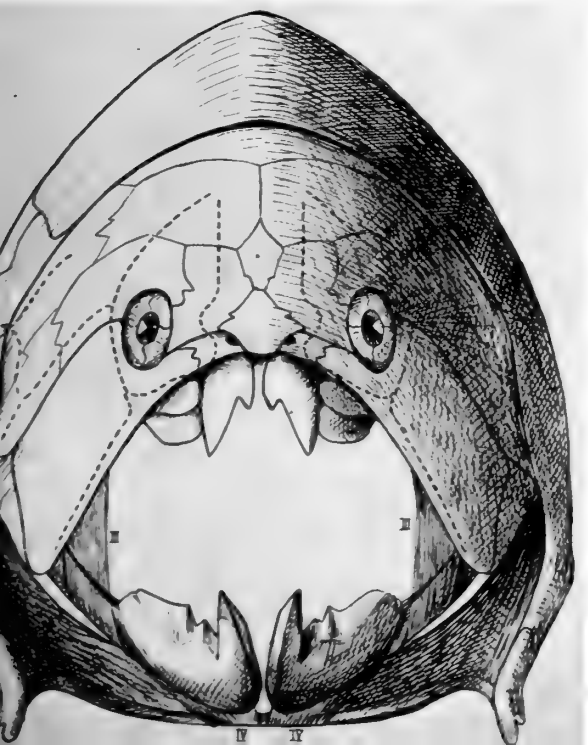
Arthrodira

(Placoderms in part)

In the Arthrodira, or Joint-Necked Fishes, the head, shoulders, and abdomen were armored with plates of bone; the jaws were

The head of a joint-necked fish: *Dinichthys terrelli* Newberry. The entire fish must have measured about 15 feet in length. Reconstructed from many fragments of Cleveland shale in the collections of the American Museum

From original restoration and drawing by A. Heintz



Head and shoulder plates of another giant Arthrodire, *Titanichthys clarkii*. Its complete length was about 20 feet

A.M.N.H. photograph

provided with "teeth" or cutting plates. These fishes ranged from a few inches to 20 feet in length and lived abundantly in the seas and rivers of the Devonian period (275 to 340 million years ago), becoming extinct during the beginning of the Coal Period (Carboniferous). They are a specialized group of Placoderms, the first of the jaw-bearing fishes.

Probably assignable to the Arthrodires are the Ptyctodontidae, a family extinct since the Devonian and known chiefly by jaws and dental plates.

Sharks

Sharks also were among the early jaw-bearing fishes and their class has survived throughout all later geologic ages.

THE FIN-FOLD SHARK, *Cladoselache*: This Shark is so named because its pectoral and pelvic fins, as well as its dorsal and anal fins, were like stiff folds of skin, strengthened internally by tapering rods of cartilage. The illustration opposite shows typical specimens as they might have appeared in life, some 300 million years ago in the Upper Devonian of Ohio. *Cladoselache* was made famous by Bashford Dean, who used it effectively in defending the "fin-fold" theory of the origin of paired limbs, which was that the pectoral and pelvic fins arose in much the same way and were made out of the same materials as the median fins (dorsal, anal, caudal), in opposition to Gegenbaur's theory that the median and paired fins had come from very different sources—the median fins from a fin-fold, the paired fins from external gills.

EDESTIDAE: These are extinct Sharks which carried a great spiral of teeth lying in the mid-line of the lower jaw. They have been found in the Permian and Carboniferous rocks of Europe and North America (approximately 225 to 275 million years ago).

←The ancient Fin-fold Shark, *ladoselache*, as it may have appeared in life some 300 million years go

toration by Bashford Dean, painted by Kako Morita

↑The huge jaws of the giant prehistoric Shark *Carcharodon megalodon*, a fossil relative of our present-day Man-eater

A.M.N.H. photograph

GIANT FOSSIL SHARK, *Carcharodon megalodon:* About the time when the glaciers covered the northern part of North America, the seas were inhabited by gigantic Sharks. The actual teeth of one of these monsters, shown above, are exhibited in the American Museum, set in jaws modeled after those of the Man-eater Shark, which is the nearest living relative of the giant extinct species. The average height of the teeth is 4 1/4 inches. The estimated length of a *Carcharodon megalodon* with such teeth would be 46 feet.

Fossil teeth of Mackerel and Requiem Sharks and dental plates of Rays are still abundant in various localities, particularly North Carolina and the New Jersey marls.

Skates and Rays

These are essentially Sharks in which the pectoral fins have been greatly widened and the entire body flattened, as discussed previously. The existing Monkfish, *Squatina squatina* (see diagram, page 24) is a direct descendant and survivor of its ancestors of the Jurassic period. It is intermediate between the Sharks and the Rays.

Some of the fossil Rays developed great crushing and grinding plates not unlike those of the recent forms.

Silver Sharks
(CHIMAEROIDS)

Chimaeroids appeared in early geologic times and were most numerous and diversified during the Cretaceous, between 60 and 120 million years ago. They form a small group of fishes whose existing representatives with few exceptions inhabit the deep sea. Complete fossil Chimaeroids are rare. They are mainly known from detached plates and spines.

The fishes of this group are interesting to zoologists as survivors of an ancient stock more closely akin to primitive Sharks than to any other fishes. In general, the Chimaeroids retain sharklike features, but in a highly modified form. The head is typically rat-shaped, and the body tapers. The tail is wispy and the pectoral fins—the main organs of swimming—are large. The numerous surface denticles of the Shark have in large measure disappeared, and the many small teeth are represented usually by three pairs of dental plates. The intestinal valve is present. The upper jaw, instead of being separate from the skull, as in Sharks, is fused with it. The skeleton is cartilaginous, and the dorsal spines strong.

Lungfishes
(DIPNOANS)

The structures distinguishing the Dipnoans are (1) a lung, which may be single or double lobed; (2) teeth, which are crushing or cutting plates with radiating ridges; and (3) paired fins supported by a jointed rod of cartilage with similar or smaller rods branching from it on either side.

The recent Dipnoan representatives are the Lungfishes of Africa, Australia, and South America (see page 26). The most ancient fossil Lungfish is the Devonian form, *Dipterus*, well known by fossil remains from the Old Red Sandstone of Scotland. It had two separate dorsal fins, and the head was covered with numerous small, enamel-coated bones.

Lobe-fins
(CROSSOPTERYGIANS)

The oldest of this group from the Old Red Sandstone of Europe, were long-bodied fishes with voracious mouths. Their pectoral and pelvic fins however, were lobate or fringe-finned, that is, they had a more or less elongate bony and fleshy core surrounded on the front and rear borders by long, fringing, bony and dermal rays. The shorter, lobe-shaped fins resembled the paired limbs of amphibians in having only a single bone, representing the humerus or the femur respectively at the proximal end of each paddle or limb. These forms, the Rhipidistia, also approached the amphibians in skull structure and are believed to have stood close to the ancestral line of the latter. The Rhipidists have two dorsal fins and a peculiar type of tail. Among the modern fishes, two genera, *Polypterus* and *Erpetoichthys* of Africa, were formerly believed to be the direct descendants of the

Devonian Crossopterygians, but Professor E. S. Goodrich has shown that they differ from the latter in many important structural features and that they may rather have been derived from ancient Ganoids of the Palaeoniscoid type.

One branch of the Rhipidists gave rise to the Coelacanths, which dated from Devonian to Cretaceous times. All but one species of them became extinct in the Cretaceous period (at least 60 million years ago), but in 1938, *Latimeria*, a living survivor of this stock was taken off the coast of South Africa (see page 29).

Ganoids

The Ganoids comprise an extensive group of fishes, whose survivors include the Sturgeons, Garpikes, and Bowfins (see page 30). The fossil members of this group were numerous during the late Palaeozoic and early Mesozoic. The older forms had prominent enameled and bony scales and in many structural features are intermediate between the Sharks and the Teleosts. The specimens shown in the exhibit are mainly from the celebrated Jurassic lithographic stone in Solenhofen, Bavaria (about 120 to 155 million years old).

The Pycnodonts (*pycnos* = "crowded"; *odous* = "teeth") are extinct Ganoids with a deep compressed body, persistent notochord, and numerous small grinding teeth. They were abundant and widely distributed during the Mesozoic era, but gradually became extinct and disappeared in the early Tertiary. Some specimens reached a length of 3 feet.

Sea Tyrants of Ancient Kansas: Among the strange fishes that swarmed in the ancient seas of Kansas, none are more noteworthy than the Amioid *Protosphyraena*, the Saw-finned Fish. Its bony snout was prolonged like that of a Gar. There were two tusklike teeth in the upper jaw, and the sharp teeth of the lower jaw were like those of the living Barracuda. The front edge of the enormous pectoral fins was serrated, and it is supposed that the fish used these in attacking its enemies.

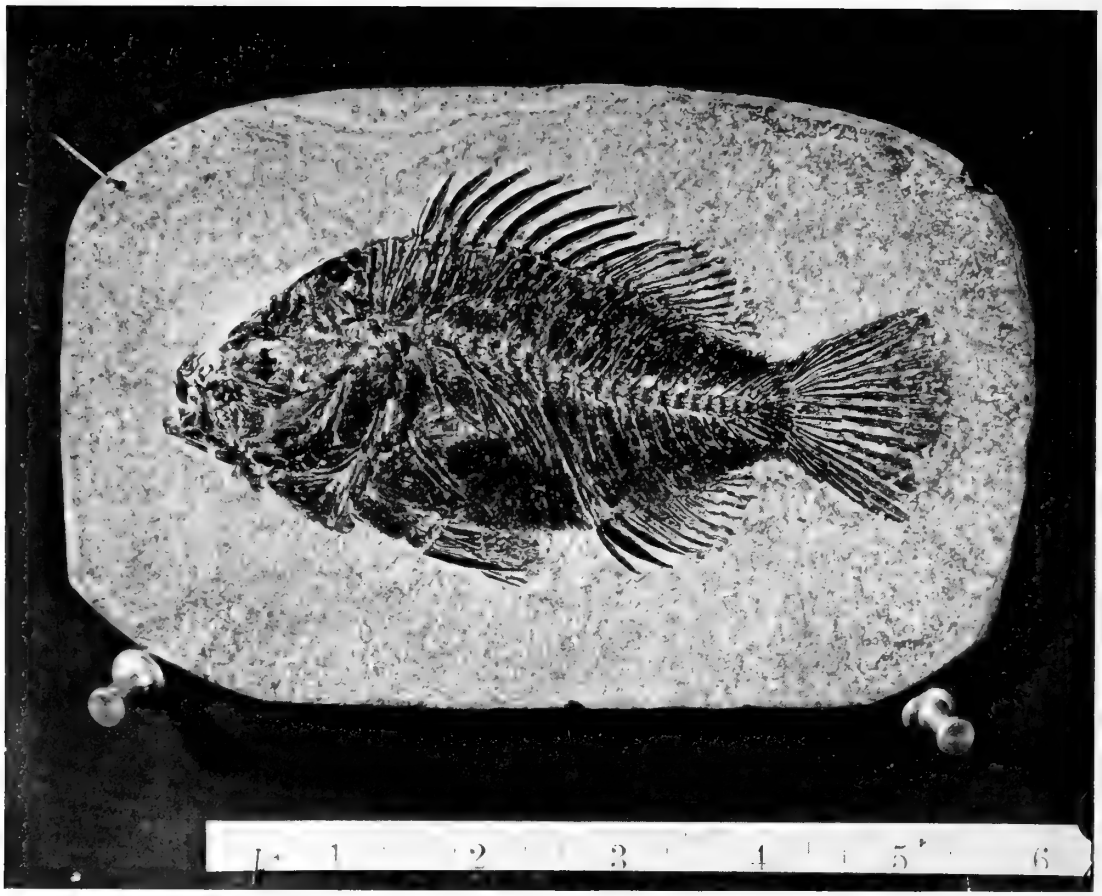
Teleosts
(Bony Fishes)

To this group, the Bony Fishes, belong the majority of food and game fishes of the world—the Bass, Carp, Cod, Eel, Herring, etc. They are the dominant type of fishes at the present time.

The Teleosts are exceedingly diverse in form, size, and anatomical structure, having become adapted to the most varied conditions in seas, lakes, and rivers. In typical Teleosts, the skeleton is bony or calcified, the fins are light and flexible, and the body is covered with thin, overlapping scales. The brain and sense organs are well developed, especially for sight and hearing.

These fishes are descended from, and have supplanted, the Ganoids. Many of their forms, including several orders, appeared between 60 and 120 million years ago, during the Chalk Period, the earliest being the Herrings (Clupeoids) and the Ten-Pounders (Elopidae). An interesting series of transition stages can be arranged, leading by almost imperceptible degrees from Ganoids to Teleosts.

The Giant Bulldog Fish, *Portheus molossus* Cope: a gigantic fossil Teleost occurring in the Cretaceous of Kansas. The specimen shown in the American Museum's exhibit measures 15 feet 8 inches in length. *Portheus* is remotely related to the existing Tarpon. Its nearest living relative is the tiny *Chirocentrus dorab* of the Indian Ocean.



A.M.N.H. photograph

↑ ***Priscacara* sp., a fossil Cichlid from the Green River Shales**

Fossil Teleosts are widely distributed. The majority of those on exhibit in the American Museum of Natural History are from the Green River shales of Wyoming. This geological formation consists of soft, buff-colored shales which appear to have been deposited in an estuary or in a land-locked bay during the Middle Eocene around 15 million years ago. The fishes found in these shales are of great variety and beautifully preserved. Those on exhibit formed part of the collection brought together by the distinguished palaeontologist Edwin Drinker Cope.

One of the beautiful fossil fish skeletons from the Green River shales at "Fossil Station," Colorado, adorns the living room or study in many homes in our country. Such specimens are frequently offered for sale as curiosities, but occasionally someone will bring in a specimen because he really wants to know how these long-extinct relatives of the Herrings, Sunfishes, and other existing families came to be preserved as fossils in such countless thousands in certain localities. Students of fossils bring their specimens to the Museum to compare them with ours, in order not only to determine the correct names for them but to learn more about the Green River fish fauna as

a whole, and if possible to find out why the descendants of some of these fishes may be found living today in the same general region, while the nearest existing relatives of others are so far away as Africa and South America.

The Green River fish fauna is only one of a long series of similar assemblages that have been found in rocks of the Tertiary, Cretaceous, and older ages ranging back for many millions of years. In the Bashford Dean Memorial collection may be seen a few samples of the fossil fish faunas of the following ages:

From the Upper Silurian and Lower Devonian periods: the Ostracoderms or oldest known forerunners of the fishes (see page 82).

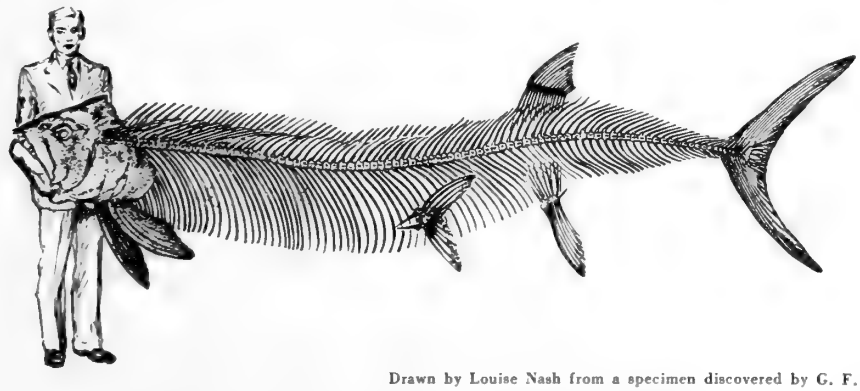
From the Lower, Middle, and Upper Devonian periods: the ancestors of the Ganoids or early bony fishes and Lungfishes (pages 86 and 87), the ancestors of the Sharks, Skates, and Rays (pages 85 and 86). From the Triassic: early representatives of the Ganoid ancestors of the Sturgeons, Garpikes, and Bowfins (page 87).

From the Jurassic: the descendants of the earlier Ganoids (page 87) and some of the ancestors of the Teleosts or higher bony fishes (page 88).

From the Upper Cretaceous: representatives of the Bulldog Fish (page 88) and other extinct side branches of the higher bony fishes, together with the direct ancestors of such modern families as the Tarpons, fresh-water Sunfishes, Perches, Basses, Triggerfishes, Angelfishes, and many others (page 88).

From the Eocene and later divisions of the Tertiary period: extinct species of modern families.

Thus the study of fossil fishes, especially during the past century and a half, has revealed that there has been a succession of fish faunas, and has provided increasing materials for the history of the main divisions of fish life. In another direction the comparative study of the skeletons of fossil and recent fishes has greatly broadened our knowledge of the early stages in the evolution of the skull, vertebral column, pectoral and pelvic girdles and even of the limbs both of fishes and of their land-living descendants, the four-footed animals.



Drawn by Louise Nash from a specimen discovered by G. F. Sternberg

The Giant Bulldog Fish, *Portheus molossus*, a fossil fish 12 feet 8 inches long found in the Cretaceous Chalk of Kansas (Between 60 and 120 million years old)

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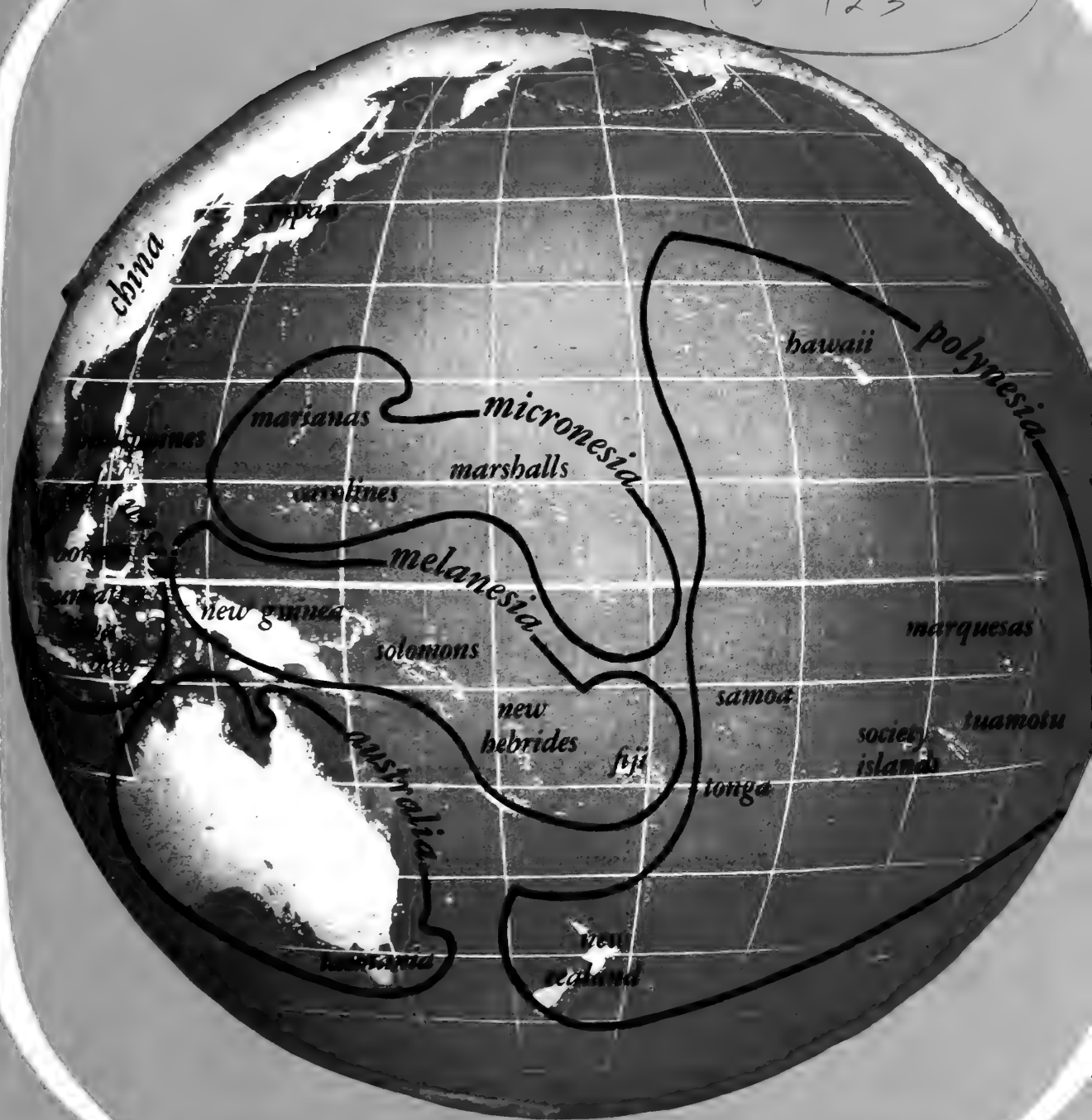

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By

HARRY L. SHAPIRO

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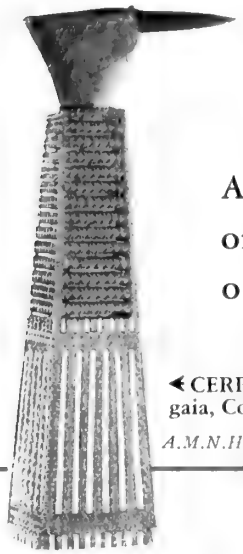


By HARRY L. SHAPIRO

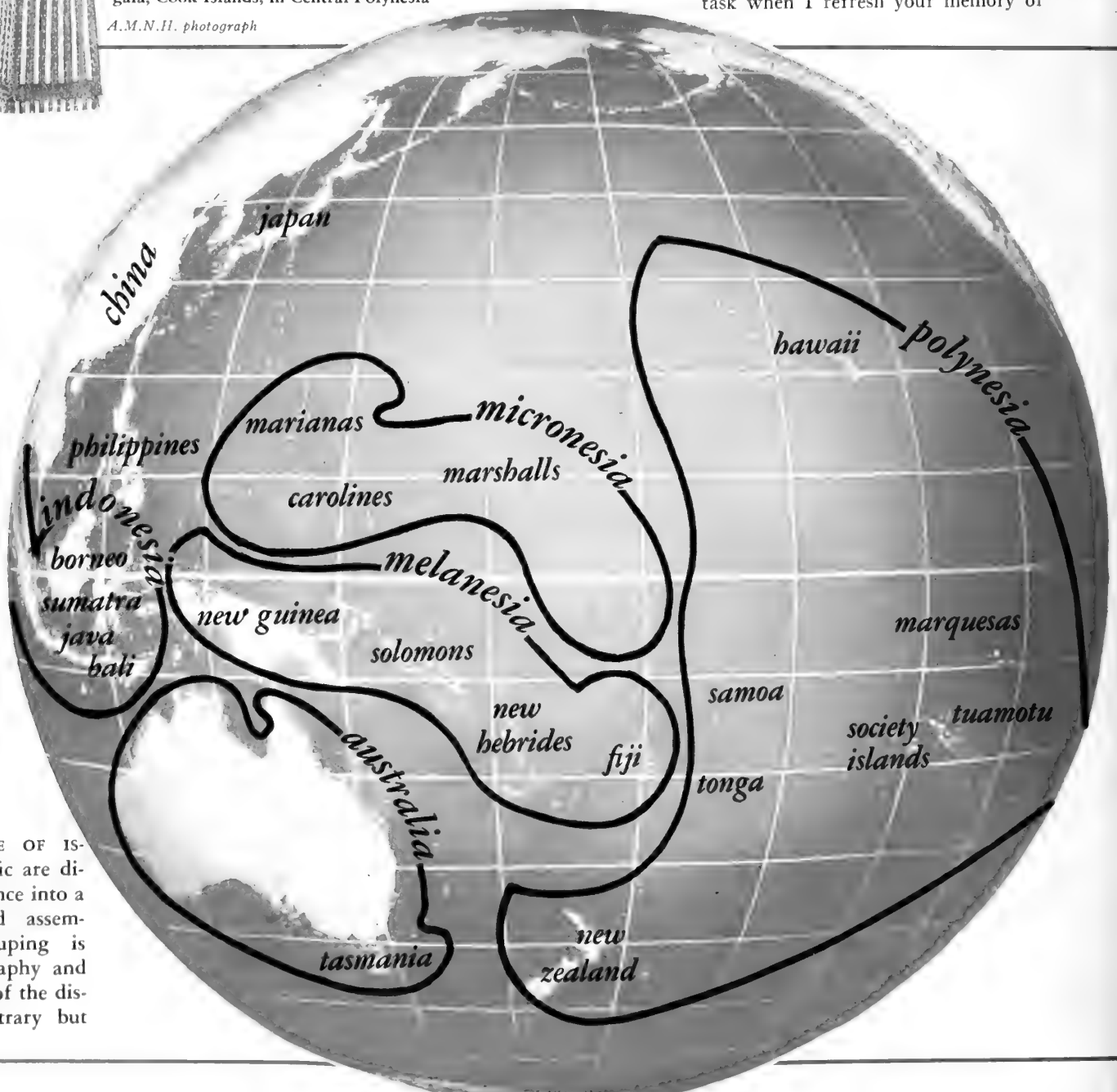
Chairman and Curator of Physical Anthropology, American Museum of Natural History

An introduction to the island natives of a vast region that has become of interest to every American

◀ CEREMONIAL ADZE from Mangaia, Cook Islands, in Central Polynesia
A.M.N.H. photograph

NEVER before in our history has our attention been so firmly focused on the Pacific. The intensity of our interest is natural when so much in our national and personal destinies is being determined there. Those of us who have dear ones fighting in the Pacific are, of course, especially eager to reconstruct imaginatively the kind of lives they are leading, to share, if only vicariously, in their experiences and to learn something of the people they will be meeting. To help you do this I shall try to tell you something of these people of the Pacific and their manners of living.

The problem of doing this adequately in a few pages is stupendous. It is like asking someone to describe in ten minutes all the varieties of race and custom to be found in the Western Hemisphere. I think you will better appreciate why it is so difficult a task when I refresh your memory of



▶ THE MULTITUDE OF ISLANDS in the Pacific are divided for convenience into a number of island assemblages. The grouping is based upon geography and population. Some of the distinctions are arbitrary but traditional

the vastness of the Pacific and the diversity of its people.

From north to south the Pacific is about 8350 nautical miles in distance. Its greatest width covers an even vaster distance. From Panama to the Philippines the distance is about 9300 nautical miles, or roughly three times the distance from New York to San Francisco. In this area which is greater than all the land area of the world put together, there are thousands on thousands of islands, some in thickly clustered groups or archipelagoes, others isolated and solitary—hundreds of miles from another speck of land. They range from huge islands that are continents or subcontinents like Australia and New Guinea to tiny coral reefs hardly rising above the surge of the sea. Some are rich in vegetation—actually jungles—, others are dry, desolate, and barren. On most of these islands native people may be found in

indonesia

a wide variety of types and living in cultures that run from the simplest forms to highly elaborate and complex civilizations—either native or European or Chinese.

Under the circumstances there is space only for a few important generalizations and a few characterizations.

You will notice that on the adjacent map of the Pacific between the Malay Peninsula and Australia lie a large number of islands large and small, closely studded and giving the appearance of a huge causeway connecting the Asiatic mainland and Australia. These, with the exception of New Guinea, constitute the East Indies. The Philippines, although not in a direct line, are essentially part of this island pathway, lying a little to the north and paralleling the Indo-China coast.

From this chain of close-set islands two separate branches emerge. The northern one, stretching eastward on the level of the Philippines, is known as Micronesia and includes the Carolines, the Gilberts, and the Marshalls. The southern line begins as an extension of New Guinea and leads in a southeasterly direction. These are the Melanesian islands, through which our troops have been forging their way recently.

To the eastward the Micronesian and Melanesian lines converge and open into the Central Pacific, into a region of far flung and scattered islands known as Polynesia. These are the classic and romantic islands of the South Seas, the scenes of Herman Melville, of Stevenson, of Nordhoff and Hall, and of *White Shadows*. New Zealand, which lies southeast of Australia and is isolated from the rest of Polynesia, is included therein because of the historical accident of its settlement by Polynesians. Hawaii, similarly separated from the central Polynesian area, lies to the north and belongs to Polynesia because its inhabitants were of the same origin.

Each of these geographic areas is characterized by people of different and distinctive racial origin and diverse cultures. Even within these large groups, minor local variations exist which make it difficult in certain respects to be dogmatic about the entire

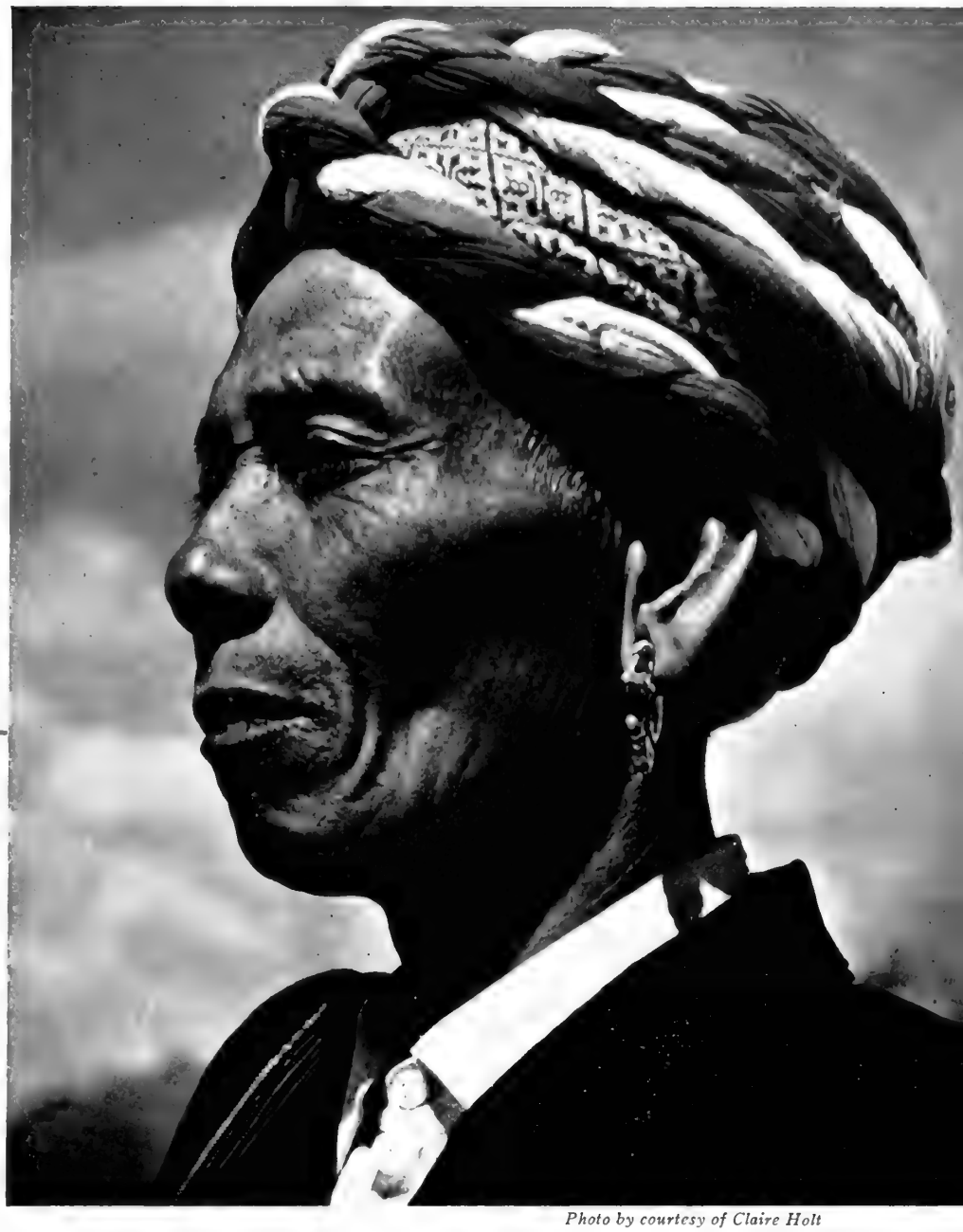
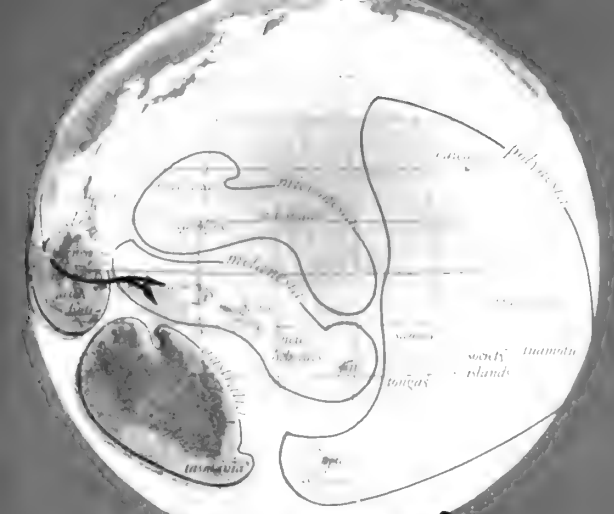


Photo by courtesy of Claire Holt

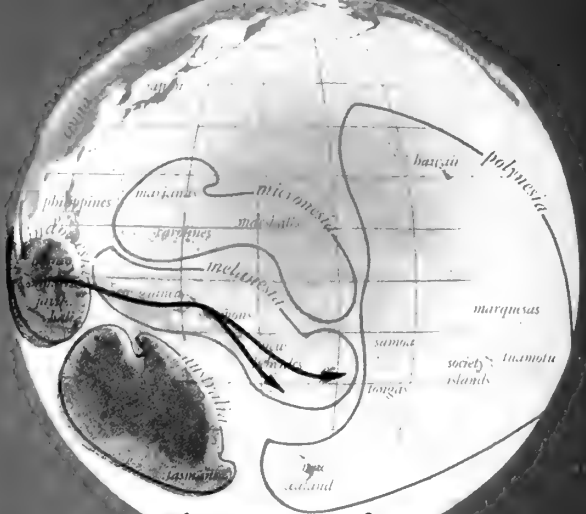
▲ THE DOMINANT PEOPLE of modern Indonesia are the Malays. Physically, their Mongoloid affinity accounts for their resemblance to Chinese and Filipinos, among whom similar or related types are found. This is a chief from a district in the northern coast of Sumatra



new guinea

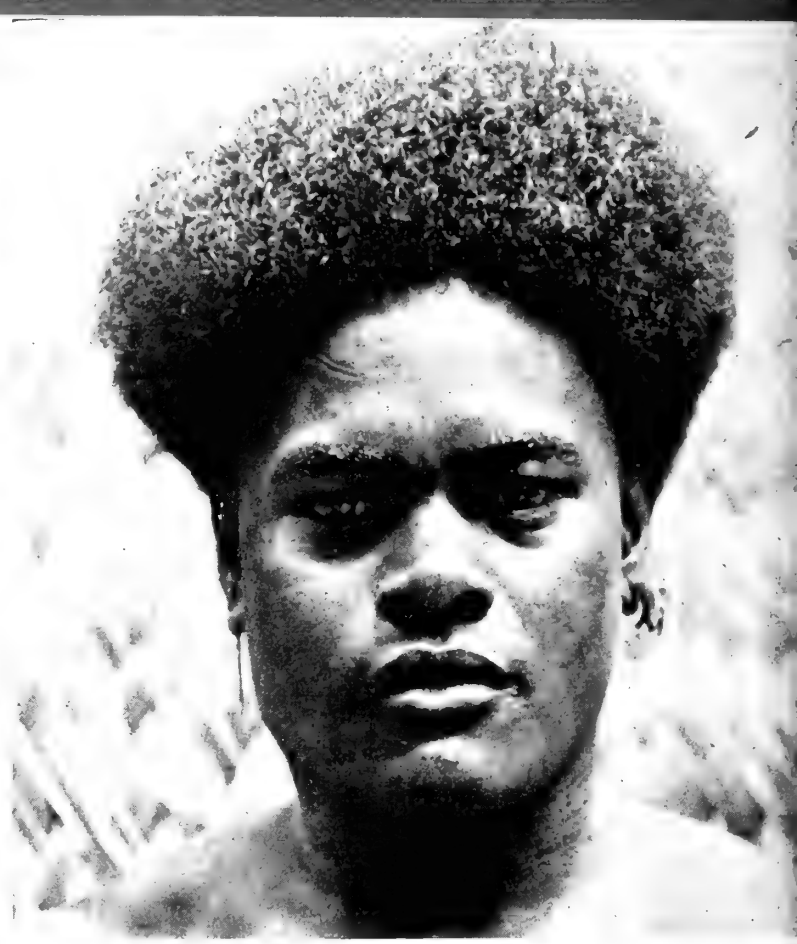
THE NATIVES OF NEW GUINEA present a wide variety of types. The one below at left is from Mt. Hagen, a little known district in the interior of central New Guinea

MELANESIANS are sometimes classified as Oceanic Negroes. This Solomon Island man with his mop of fuzzy hair is representative. Melanesian Islanders are frequently employed on large plantations run by Europeans. In the old days they were impressed into service against their will by "black birders"



melanesia

Photo courtesy of M. J. Leahy

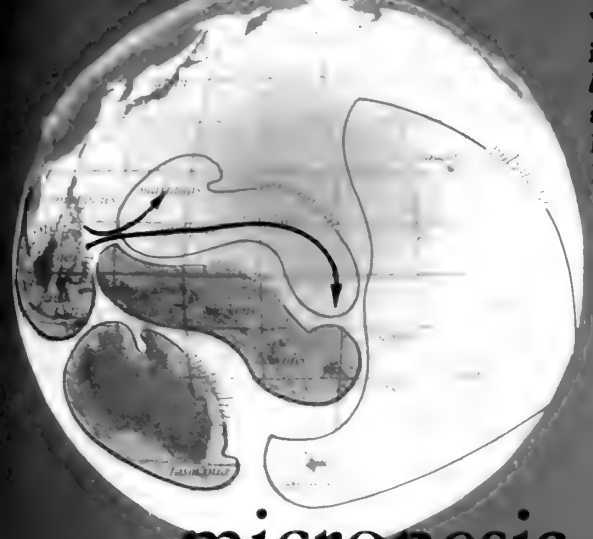


Photograph by H. Ian Hogbin

brow and strongly projecting face. He is almost black in color and has wavy hair abundant on head and body. His equipment of tools and gear is simple and restricted, although he has the remarkable boomerang. His life is harsh and precarious. Clothing is scant or absent, and shelter is at a minimum. He is, however, noteworthy among anthropologists by virtue of his highly complicated kinship system regulating marriage and his reputed ignorance of the facts of life, at least some of them. The role of the father in reproduction is not understood by these people.

The Melanesians and the natives of New Guinea may be grouped together in spite of distinctions which are commonly drawn among them. They are a dark brown people, usually having frizzy hair, broad flattish noses, and protruding faces. They are sometimes called Oceanic negroids because of their resemblance to African Negroes. Pygmy people of unknown origin live in the interior of New Guinea and the New Hebrides. These are the people whom our soldiers are meeting now in the Solomons, in New Britain, and New Guinea. By our esthetic standards of physical beauty they fall far below the Polynesian, although many of them are strong and robust.

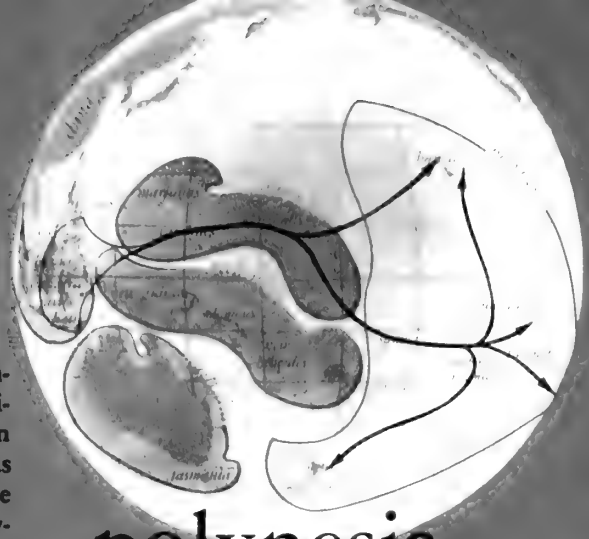
The Melanesians as well as the Australian aborigines were not as highly developed in the nautical arts as the Polynesians, which accounts for their inability to move beyond their present island homes. To reach these islands, no great skill was required, since they are large, high islands, often within easy reach of each other. Thus even with primitive means of navigation the natives could reach their present settlements. They probably represent an early migration from more westerly islands, moving eastward under pressure of invading forces.



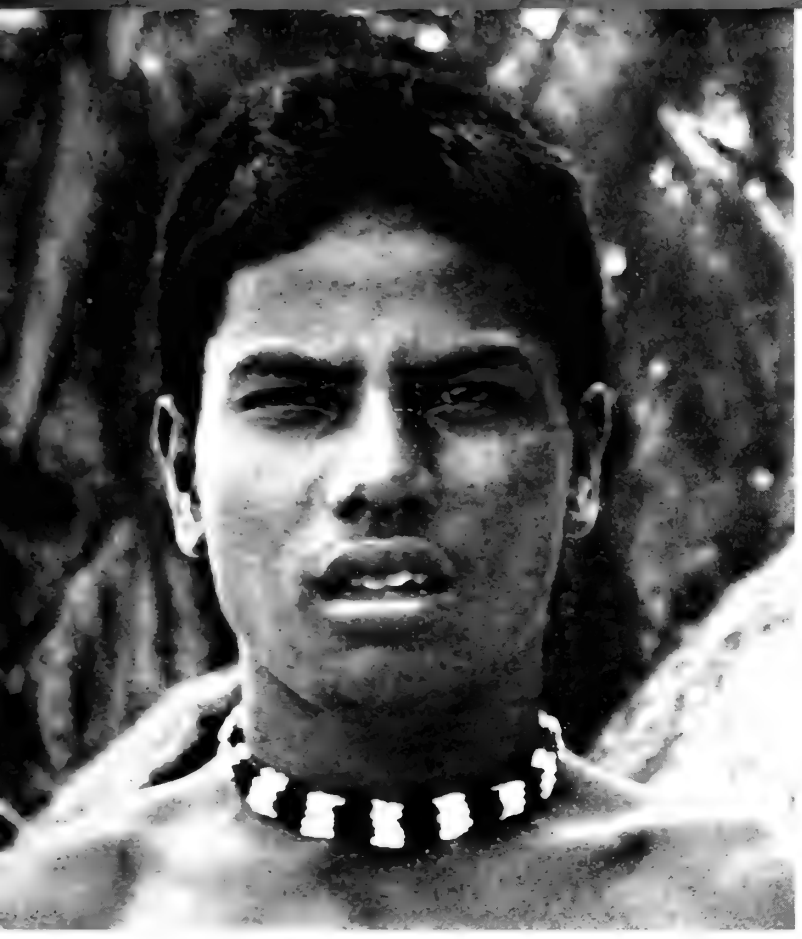
micronesia

▼ THIS NATIVE of the Gilberts in eastern Micronesia *(lower left)* is quite unlike the characteristic type of the western Micronesia population, where Malay influence has infiltrated

▼ POLYNESIANS are the latest comers into Oceania and have migrated farther into the Pacific than any other people. The Marquesas Islands, the home of this man, lie on the easternmost limit of Polynesia. The maps in this panel show the successive migrations



polynesia



Photograph by Albert G. Mayer, A.M.N.H.

Photograph by Harry L. Shapiro

Melanesian culture and language are highly variable. Students have found profound differences within short distances. These circumstances make it difficult to generalize for the whole group. Nevertheless, certain common features do occur widely in this area. A noteworthy decorative skill is especially interesting. It expresses itself on some islands in wood carving, on others in ritual objects and masks of intricate color and bold design. These ritual paraphernalia are associated with highly organized secret societies in which the entire community is involved. Indeed, secret societies seem to have run rampant. The technique of the personal build-up also reaches unusual levels here in Melanesia. To acquire prestige some groups go in for complicated systems of giving away valuable objects, others by piling up mountains of food for huge feasts. The extreme development of the aristocratic and caste system formerly characteristic of Polynesia seems never to have evolved here.

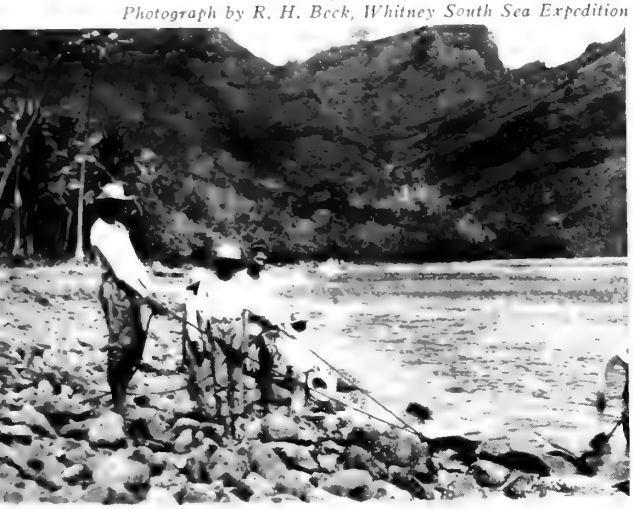
Melanesian houses are generally simple one-room affairs, a cover of thatch over a light frame. Frequently the houses are raised on stilts, which makes a convenient dumping ground available just under the floor. The pigs, which are ubiquitous, make good scavengers and keep the villages fairly clean. Many of these villages have a much larger building elaborately decorated for use as a kind of men's club, forbidden to the women, and as sleeping quarters for adolescent boys.

Gardening is a more frequent occupation here than in Polynesia. Gardens are an important source of food. The forest is slashed and burnt by the men, and the women take over, using a hoe culture. Some of the more important food crops include the leaves and starchy rootstocks of the taro, sweet

▲ FISHING is one of the mainstays of Polynesian life

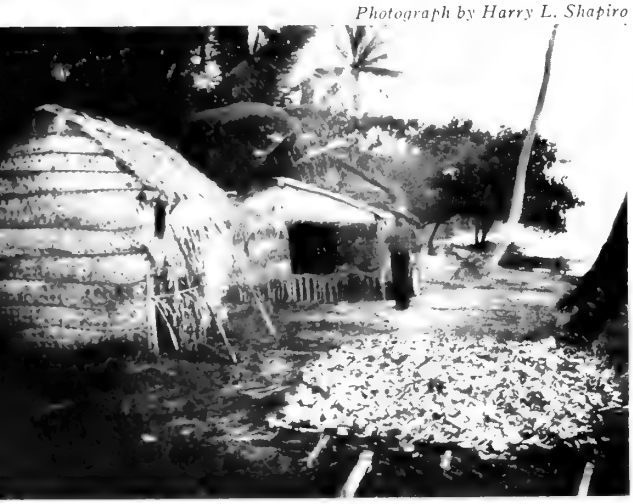
▼ MARQUESAN NATIVES cutting up a manta on the beach

Photograph by R. H. Beck, Whitney South Sea Expedition



▼ THE MEAT of the coconut, only cash crop of Polynesia's coral atolls, is dried and sold to traders

Photograph by Harry L. Shapiro



▼ TUAMOTUAN natives used to transport soil from Tahiti to make beds such as this for growing taro

Photograph by Harry L. Shapiro

Photograph by Harry L. Shapiro

▲ THE CLEAN CORAL sand makes excellent village streets. This village in the Tuamotus is like many others—coconut trees and sand. Modern houses are built of planks and roofed with tin

▼ FISHING is one of the arts of Polynesian life. Lines, nets, and traps were used. Most of the old fishing gear has survived European influence

polynesia

➤ ONLY IN THE REMOTE DISTRICTS do the older thatch roofed houses survive. This one is the home of the chief of Rapa. The thatch is commonly made of pandanus leaves, folded over the midrib of a coconut leaf

Photograph by R. H. Beck, Whitney South Sea Expedition

Photograph by R. H. Beck, Whitney South Sea Expedition

➤ THESE RAPA GIRLS are paddling home from the taro fields which are some distance from the village. Taro is an important food plant throughout Oceania. Fermented taro makes one form of poi—a widespread native dish

➤ THESE NATIVES OF RAPA gather on the jetty to welcome or to speed their guests. The isolation of the island lends a special festivity and excitement to the arrival of any visitors

Photograph by R. H. Beck, Whitney South Sea Expedition

australia

Photograph by Spencer

➤ AUSTRALIAN ABORIGINES are largely confined at present to central and northern Australia. Their number is estimated at around 10,000. This Kaitish man has a typical hair-do and a slit nasal septum for holding ornaments

➤ THE POVERTY AND SIMPLICITY of Australian life is suggested in this picture of an Arunta woman and child. Clothing is scanty or absent, equipment simple, and shelter at a minimum

➤ ALTHOUGH THE MATERIAL ASPECTS of aboriginal life in Australia are severe and primitive, their social and ceremonial life have some highly evolved elements. The ceremonial episode below depicts a thalaualla (black snake) drawing on the ground, with participants in full regalia. Some of the men are wearing elaborate head dresses. Their torsos are covered with feathers stuck to the body with human blood. The celebrants belong to the Warramunga tribe

potatoes, yams, pumpkins, squashes, bananas. Pigs and small game furnish most of the flesh foods.

Speaking of food reminds me that some of the Melanesians are notorious for their addiction to human sources of meat. Cannibalism until quite recently was not unusual in some of these islands. When I was on Norfolk Island in 1923 we received reports of the murder of several missionaries in the New Hebrides who were eaten by the native tribesmen. Although this vicious practice had been associated only with the Melanesians, it formerly was more widely spread and was known to occur even in Polynesia. On a visit in 1929 to the Marquesas in eastern Polynesia I met one old man who told me that as the son of the chief he was entitled to a finger of the victim, a morsel which he recalled as tasting quite good. Within

➤ THIS GROUP of old men were in charge of a tribal gathering held at Alice Springs. Each of them is the head of a totemic group. The shelter is constructed of boughs

Photos courtesy of Capt. Frank Hurley

▲ A NATIVE of New Guinea. Decorations and hair-do vary from tribe to tribe

▲ THE MEN'S CLUB HOUSE: usually an impressive part of Melanesian and New Guinea villages

▲ THE LOVE OF FINERY is universal. These native girls are adorned with flowers, seed necklaces, and shell ornaments

◀ A MANUS CHIEF paddling his outrigger canoe. Manus is one of the Admiralty Islands recently captured by our forces in the Southwest Pacific. The native village on Manus is built on piles standing in a lagoon

Photograph by R. H. Beck, Whitney South Sea Expedition

melanesia

◀ IN THIS ROW of boathouses are lodged the large canoes drawn up on the beach. The canoes are seaworthy enough for long voyages and are characteristic only of a limited part of the Papuan Coast of New Guinea

Photo courtesy of Capt. Frank Hurley

Photo courtesy of M. J. Leahy

▲ THIS VILLAGE, set among the mountains of the interior of New Guinea, was only recently discovered. It is an unspoiled example of native life, untouched by European influence

Photo courtesy of M. J. Leahy

➤ THE RARITY of a European spoon in central New Guinea endows this lowly utilitarian object with the glamour of a jewel. The beard is apparently dense enough to hold the spoon

▼ THE MINT on Malaita, in the Solomons. Shells cut into discs and strung on fibers constitute money for these Melanesians. The process of manufacture is long and laborious

the past decade, however, cannibalism has disappeared even in the remote islands of Melanesia.

Micronesia, which lies to the north of New Guinea and the Melanesian islands, includes the Marianas or Ladrones, the Palaus, the Carolines, the Marshalls, and the Gilberts. These groups begin to the east of the Philippines and continue along the tenth degree of latitude north of the equator, dipping south at the Gilberts toward Melanesia and Polynesia. Less is known about the people of these islands than about the Polynesians and Melanesians. During the Japanese mandateship, visitors and scientists were rigorously excluded for reasons which are well known to us now.

Physically the Gilbert and Marshall islanders approach the Polynesians in appearance, and much of their culture has similar relationships. But the material poverty of their low coral islets has inhibited the development or maintenance of a rich culture. The Gilbertese used to be famous for their armor woven from coconut fiber and their weapons studded with shark's teeth. A high degree of maritime skill was also characteristic.

As one moves westward toward the Asiatic mainland and the islands of the East Indies, the physical type becomes progressively more like the Malay until in the Palaus, Marianas, or in the western Carolines the Malay infiltration is very marked. The influence is by no means confined to racial characters. Many Malay cultural elements have also greatly affected western Micronesia, yet are absent farther east. For example, the chewing of betel nut is common in western Micronesia but is unknown in the east.

The East Indies are commonly typified in our minds by huge islands such as Java, Sumatra, and Borneo. But there are many more than these few imposing islands. From Sumatra, hugging the west coast of the Malay Peninsula, to the eastern islands off the shore of New Guinea is a distance of over 3000 miles. Within these limits lie thousands of islands, mostly of volcanic origin. Here live 70 million people, over half on the island of Java alone. The Philippines, just north of Central Indonesia and adjoining Borneo, are sometimes considered apart from the East Indies. Their cultural and racial affiliations with Indonesia, however, are so intimate that aside from geographic reasons they should be linked with the East Indies.

micronesia

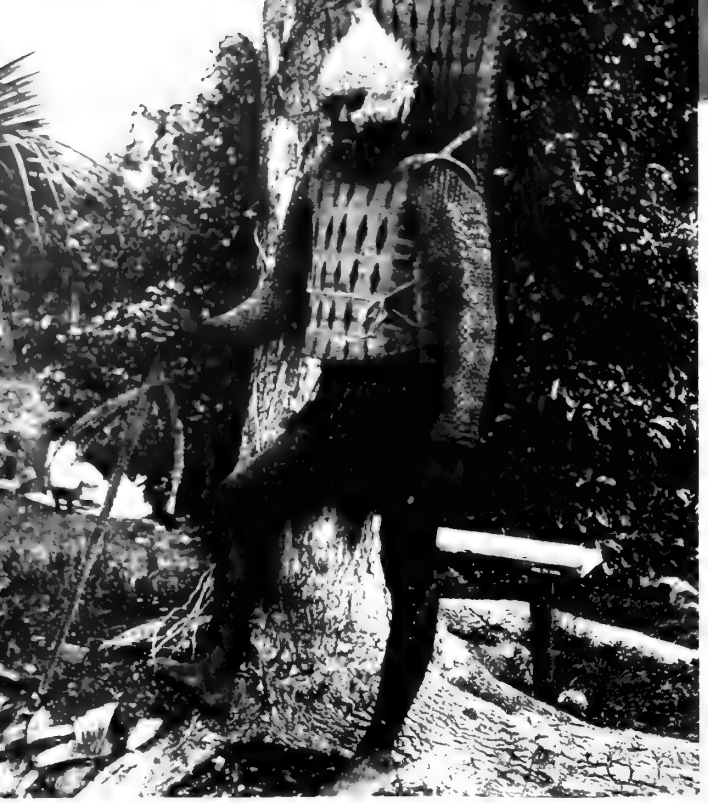


Photo by C. H. Townsend

THE GILBERT ISLANDERS were famous for their armor, woven from heavy coconut fiber. This warrior carries a shark-tooth weapon and wears a helmet made from the dried skin of the blowfish

THIS SCENE in the lagoon of Truk shows the local variety of outrigger canoe. Such craft are speedy and require skill in handling

Photograph by Albert A. Mayer, A.M.N.H.

SCENE ON THE KAYAN RIVER of Northern Dutch Borneo. The large Indonesian islands are almost continental compared with the small islands of Polynesia and Micronesia. As a result, Indonesian life is less restricted to a shore line occupation

THE CULTURE OF INDONESIA reached high levels in pre-European times. Java was once a powerful kingdom with a complex civilization derivative in part from India. This relief cut in stone is part of the famous temple at Borobadur in Java

Photo courtesy of Claire Holt

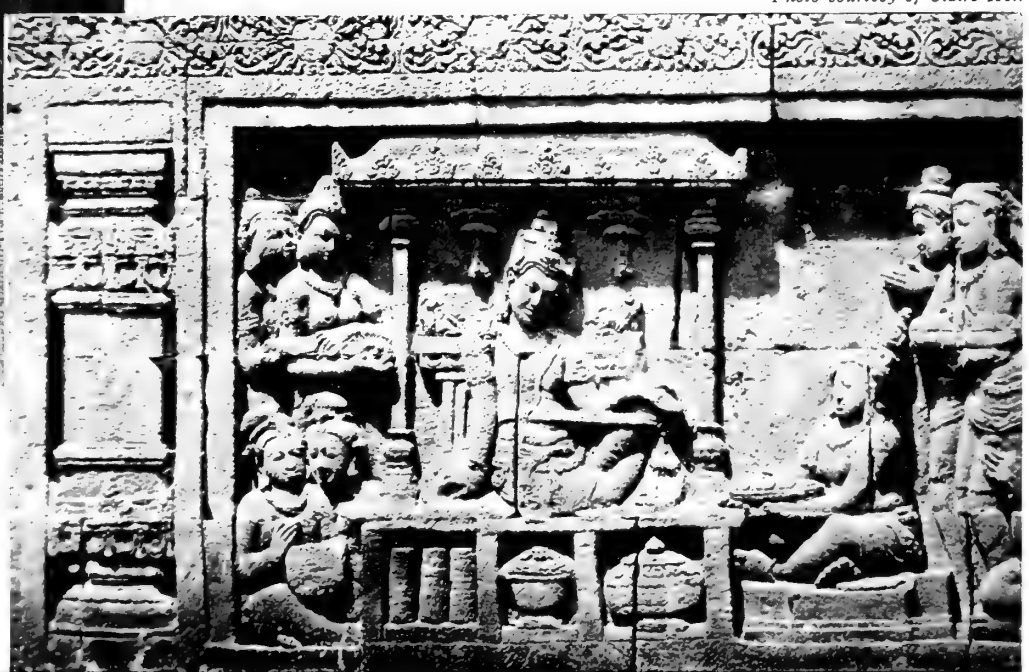


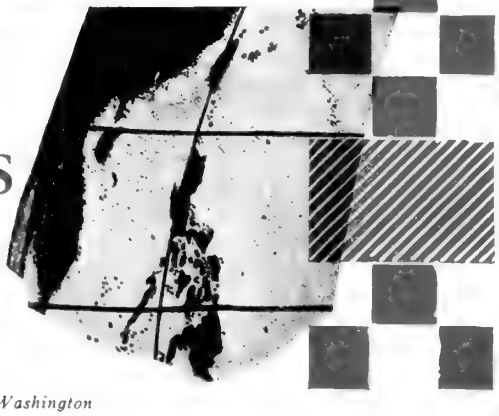
Photo courtesy of Carl Lumholtz

indonesia

Photo by Jessie Tarbox Beals

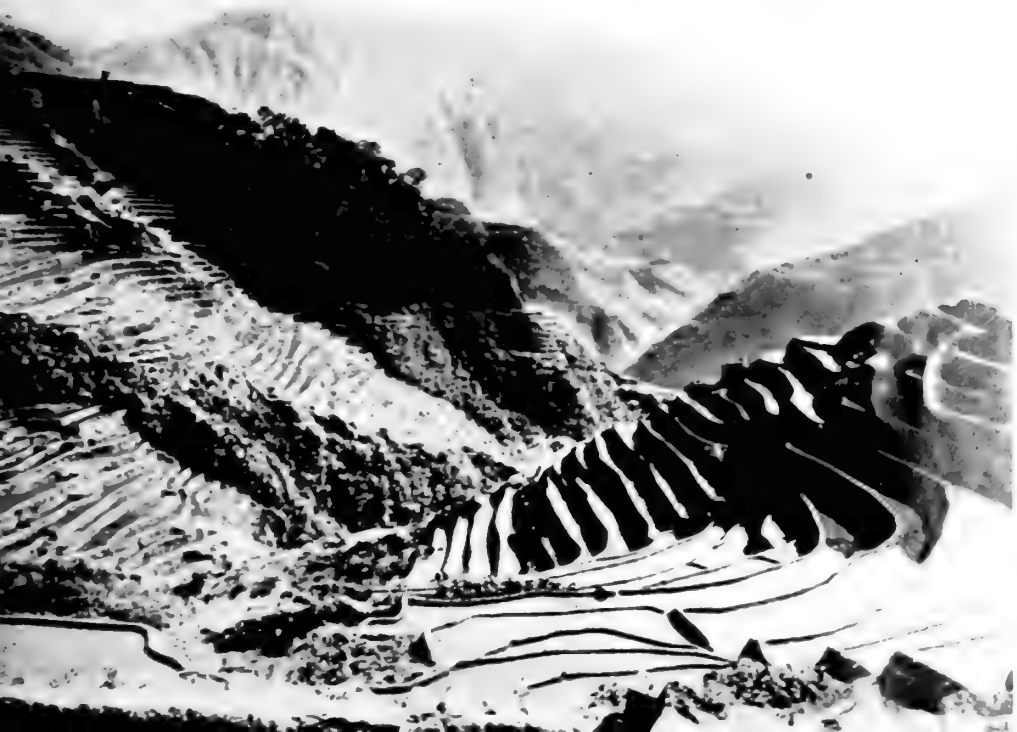
▲ MANY OF THE FILIPINOS are Malay in origin, although traces of other races have survived. These Bagabo warriors are representative of the prevailing Malayan strain

philippines



▼ THOUSANDS OF MILES of stone retaining walls are required for the construction of these terraced hills, one of the most remarkable engineering structures in the Philippines

Courtesy of Bureau of Insular Affairs, War Department, Washington



The people at present dominant in the East Indies are the Malays, who constitute a branch of the Mongoloid group of mankind. They are short, often muscular, with straight black hair, brown skin, a broad flattish face, full, somewhat bulbous brow, and moderately thick lips. The Javanese are of this type. The highest developments of native culture are generally associated with the Malays.

An earlier invasion of Malay people sometimes called Proto-Malays with less obvious Mongoloid traits is now represented by people living in the interior of the large islands of the East Indies or on the remoter small ones. Traces of earlier populations that once lived in these islands can still be found scattered throughout the region. The primitive Australian aborigine must have passed through these islands on his way to Australia. Although little trace can now be discovered of him, there is much more evidence of his successor and follower, the Melanesian, who still reveals his presence in the population of the eastern islands of Indonesia. Pygmies similar to those found in Melanesia still survive in the Philippines. It is worth recalling that in the remote past one of the earliest and most primitive human types existed on Java. This is the famous *Pithecanthropus erectus,* whose fossil remains are dated as far back as a million years.

It is impossible to characterize the pattern of life in this area, as it varies enormously. Some cultures are quite simple and reminiscent of those we have already described. Others such as the civilizations of Java, of Bali, and of Sumatra, are highly organized, complicated societies with elaborate political and religious structures, magnificent art and architecture, native music and dances of extraordinary development, and a multiplicity of exquisite crafts and manufactures that bear comparison with our own. Indonesia is in reality a region where high civilizations have flourished long before the advent of the white man. It has had long and intimate contacts with the civilizations of the mainland: India, Malaya, and China. For centuries these islands have been the principal goal of Chinese emigrants, who were firmly entrenched in the commercial life of the islands. From these islands came at least one of the major elements in the Japanese population, and traces of this origin are still plain in Japanese culture.

OTHER PUBLICATIONS ON Peoples of the World

Order any of these items from Man and Nature Publications, The American Museum of Natural History, Central Park West at 79th Street, New York 24, New York. They are all published by the American Museum

PEOPLES OF THE PHILIPPINES. By A. L. KROEBER. *244 pages, 50 illustrations. Cloth bound. Second edition, revised. 1943. Price, $1.00; postage, 7 cents.*

This comprehensive handbook on a region that has become increasingly important in recent years should prove useful to men in the service and to students of anthropology, as well as to the casual reader. It presents an interesting account of the racial and cultural background of the islands and discusses the art, occupations, and religion of the natives. It is a valuable aid to the visitor in the Philippine section of the Museum, whose collections provide illustrations for many of the subjects presented.

THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER. *64 pages, 27 illustrations. Paper bound. Fifth edition. 1932. Price, 20 cents; postage, 3 cents.*

Few subjects make a more forceful appeal to the student, historian, or even the general reader, than the native Americans who occupied what is now Greater New York. Yet it is very difficult to obtain information on them, for the few accounts which the Colonists left us are in tomes that are rare and difficult of access. This booklet briefly supplies the available information, discussing the life of the natives, their costume, religion, and archaeology.

THE MAORIS AND THEIR ARTS. By MARGARET MEAD. *38 pages, 23 illustrations. Paper bound. 1928. Price, 15 cents; postage, 3 cents.*

This traces the background of native New Zealand art through the organization of Maori economy, society, and religious life. It gives a description of the construction, decoration, and uses of their carved jade *hei-tikis*, their carved communal houses, and elaborately decorated wooden canoes. Weapons, textiles, and tattooing are discussed with special reference to the facial designs and the custom of preserving heads after death. Interesting to student and layman alike.

INDIANS OF THE NORTHWEST COAST. By PLINY EARLE GODDARD. *175 pages, 103 illustrations. Cloth bound. Second edition. 1934. Price, $1.00; postage, 7 cents.*

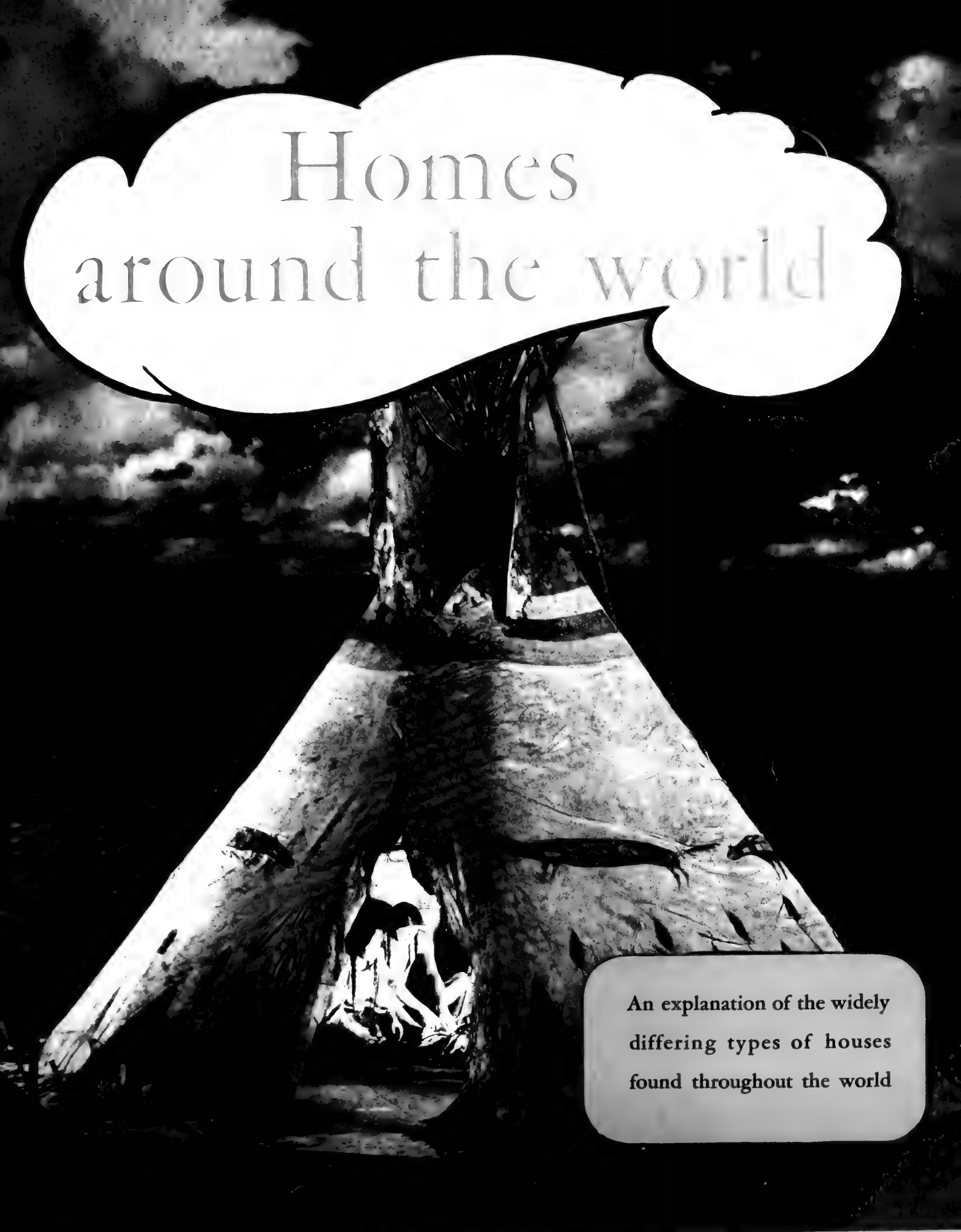
This plainly written account relating to the work and exhibits of the Northwest Coast Indians Hall in the American Museum is valuable not only to the visitor wishing additional information but also to anyone interested in the Indians of this area. It discusses the topography and climate of the territory along the coast from the Columbia River in Washington to southern Alaska, as well as the customs, religion, and art of its inhabitants, expert workers in wood and carvers of totem poles.

NORTH AMERICAN INDIANS OF THE PLAINS. By CLARK WISSLER. *172 pages, 64 illustrations. Cloth bound. Third edition. 1941. Price, $1.00; postage, 7 cents.*

This well illustrated and clearly written handbook is a summary of the facts and interpretations of the culture of the Plains Indians. It serves as a guide to the American Museum's collections and will give the visitor a broader understanding of the materials on display. Further, it acquaints the student and general reader with many of the basic points in the study of this North American Indian culture, including marriage, social and political organizations, and language.

INDIANS OF THE SOUTHWEST. By PLINY EARLE GODDARD. *205 pages, 71 illustrations. Cloth bound. Fourth edition. 1931. Price, $1.00; postage, 7 cents.*

This book will be useful not only to the Museum visitor who desires more information about the subjects illustrated by the collections in the Hall of Southwest Indians, but also to the student of American history and culture. It offers a review of the facts concerning both the prehistoric and historic natives of our Southwest. Among the subjects treated are the Spanish conquest, the Pueblo and Village Dwellers, the nomadic peoples, cliff dwellers, native weaving, the potter's art, and the Hopi Snake-Dance and other ceremonies.



Homes around the world

An explanation of the widely differing types of houses found throughout the world

By HARRY L. SHAPIRO

THE AMERICAN MUSEUM OF NATURAL HISTORY

HOMES AROUND THE WORLD

By

HARRY L. SHAPIRO

MAN AND NATURE PUBLICATIONS

Science Guide No. 124

THE AMERICAN MUSEUM OF NATURAL HISTORY

Central Park West at 79th Street, New York 24, N. Y.

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BE IT EVER SO HU

ESPECIALLY impressive among the many interesting collections of the American Museum of Natural History is a large assortment of models illustrating the various types of houses built by primitive man throughout the world. This article is based on this collection.

In the Museum, the models are scattered through many halls; here a selection of the most significant ones is gathered together for the first time as a unit for study and comparison. Some of the models are portable and are circulated among schools along with other exhibits, by the Museum's Department of Education. Others are life-size replicas.

The scientific care with which they have been constructed can be understood from the fact that in many instances several years of study in a single group of people have preceded the actual construction of one of the models. The more elaborate ones required months of work by skilled technicians. The collection as a whole is probably the finest and largest in the world.—ED.

ALL PHOTOS A.M.N.H.

PART I

As thoughts turn more than ever to other lands and other climes, it is astonishing to discover how many curious patterns people around the world have followed in making themselves a home

▼ NEAR THE TIP of South America we find the simplest of dwellings, a crude windbreak that serves as the only shelter for the Ona family in a chilly and windy climate. Being nomadic, the Onas must be able to carry their shelter with them in their wanderings in search of food. Six to sixteen skins of the guanaco, a relative of the llama, are used in one of these windbreaks. The hair is scraped off, and the skins are smeared with grease and red ochre

▼ PORTABILITY is again a v
feature of the tepee of the Pla
Indian. But even where life
pends on frequent movement
search of game, the house provi

MBLE

By HARRY L. SHAPIRO

rator and Chairman, Department of Anthropology, The American Museum of Natural History

more than mere protection from the elements. It affords privacy from the publicity of community life and unites the family in mutual endeavor

IT IS NECESSARY, I suppose, if we are to get on with our daily tasks, for most of us to take for granted the paraphernalia, frequently ingenious, by which the human organism maintains its comfort and extends its powers. Yet it is a source of wonder how nicely every tool, every item of gear and equipment, every article of clothing represents an extension of the human body and its needs, and usually reveals a history of increasing adaptation and efficiency.

The house illustrates this principle perhaps as well as any other object of man's material culture. But in one respect the house is probably unique. All other inventions and artificial devices of human culture originate exclusively in *human* experience. Even the rudest tools known to us are human inventions. No animal, not even the anthropoid ape, has ever been known to chip a stone with deliberate intent to fashion a tool. They may use a stick, a stone, or even a coconut as a ready-made device, but they do not transform the raw product into something new by conscious and purposeful effort. Thus none of our gear, even in its most primitive forms, has any prototype among the subhuman animals.

The house, however, is the only exception to this rule. Its counterpart is widespread in the animal kingdom in the form of nests, shelters, hives, and various other artificial structures. And it is as truly an artifact as anything in man's equipment.

▼ THE ESKIMO snow house, perhaps more than any other dwelling, illustrates how a house surrounds its occupants with an artificial climate in which greater comfort, sometimes survival itself, is possible. The colder it gets outside, the warmer can the Eskimo heat his snow hut without weakening the walls. The interior can be kept well above freezing by burning the seal oil lamp, particularly if skins are pegged to the walls to form an insulating layer of dead air

▲ PEOPLE of the old Stone Age found shelter in natural caves and rock crevices. If they developed any sort of domestic architecture beyond the most elementary use of branches and leaves, all traces have been destroyed by time. This model, recently completed in the American Museum, shows human life about 500,000 or 600,000 years ago on the Somme River in France. (Chellean Culture)

▼ MAN'S EARLIEST HOME, the cave or natural rock shelter, has also been used down to recent times by some peoples. The model below shows one on the northern end of New York City's Manhattan Island (Inwood Park), a settlement that was occupied by Indians when this region first felt the influence of European civilization. Thus we see the earliest type of dwelling almost under the shadow of the tallest buildings man has ever contrived to build

THE precise evolution of the human habitation from its simplest precursors is difficult, if not impossible, to unravel. Primitive man, who often lived in caves where these were available, has thus far not provided us with any remains of his more ephemeral efforts to provide shelter for himself. The chances are that we shall never find any such traces, since the earliest representatives of mankind could have used only perishable materials for such structures. In all likelihood primitive shelters were of the crudest character, only little advanced beyond the nests that the anthropoid apes construct for themselves in the branches of trees.

Some writers have assumed that the origin of the house goes back to the use of caves, and that the evolution of masonry and stone construction arose out of the efforts of the cave dwellers to close the openings of their shelters with walls. This sequence, however, seems more fanciful than real. In the first place, primitive man probably inherited from his primate ancestors a tradition of nest building that he could easily adapt to his needs. Furthermore, masonry is by no means universal, and where it does occur it appears to be relatively late rather than early in the history of the house. In Europe, for example, remains of wattle and daub houses found as far back as the Neolithic antedate evidence of the use of stone construction.

In any event, it seems most likely that the house went through multiple lines of development, according to circumstances, rather than a single evolutionary sequence. It is more accurate to conceive of its development as varying among diverse peoples, taking directions that material, environment, and skill suggested. In some instances, indeed, little or no progress whatever can be detected, with the result that at present almost every stage of complexity may be seen in the contemporary housing of mankind. Men live in caves today, as they did 50,000 years ago. Windbreaks of the simplest construction serve now as they have in all stages of human history. This very multiplicity of house types found throughout the world leaves no doubt that the human habitation has had a complex history of development and adaptation.

The variety of house types in use brings to mind the old French saying, *"Plus ça change, plus c'est la même chose"*—the more it changes, the more it remains the same thing. The diversity of domicilary styles should not mask for us the fact that the basic needs a house is designed to satisfy are constant necessities which all forms of habitation serve with more or less efficiency and elegance.

storage

▼ GROWTH OF THE HOME beyond the limit of a single room was stimulated largely by the need of storage space for food, implements, and other goods. In this model of a Koryak village on the seacoast of eastern Siberia we see a small shed for such properties (*center foreground*). At extreme left is a storeroom on a platform for protecting winter provisions. It is elevated to keep the food from dogs and wild animals

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storage

▲ A CORN CRIB constructed of cane illustrates the necessity for the storage of food among agricultural natives even on a relatively low stage of culture. This is a reconstruction of a Natchez Indian community in eastern central United States. The conical roofs of both the hut and the storage chamber are of matting. The "pyramid" in the distance, known through archeological excavations, presumably had some role in the spiritual life of these Indians

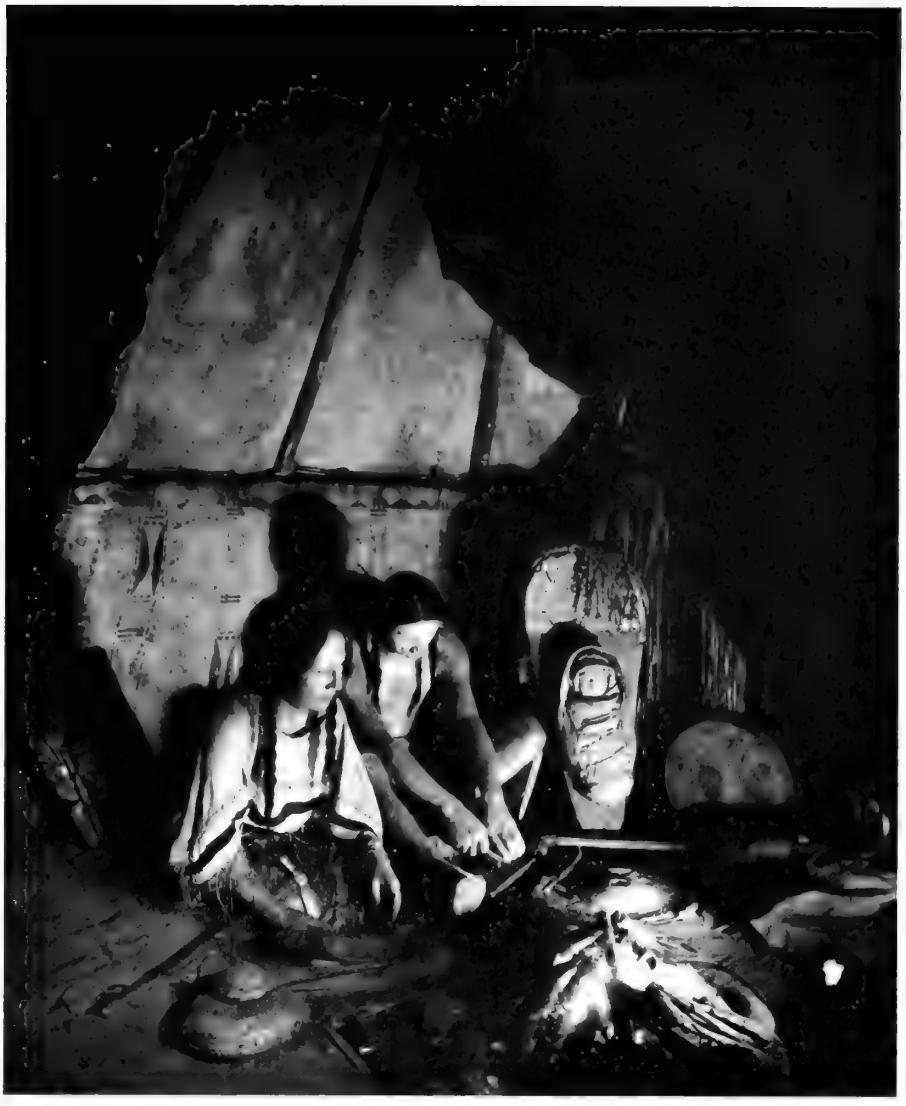
THE fundamental needs that a house must fulfill are simple and universal. A house or shelter must provide protection from the weather, from cold and snow in cold climates, from heat and rain in warmer ones. In a very real sense, the house surrounds its inhabitants with an artificial climate in which greater comfort is possible, and upon which, in certain severe circumstances, existence itself depends. The human organism by itself is not able to meet all the rigors of the weather. The natural protection that other animals have in pelt, hide, and fatty deposits is inadequate in man, who seems to have evolved in a warm climate where such anatomical accessories were unnecessary. But since he has ventured into every corner of the earth, into regions for which he was not adapted by nature, he has been forced to acquire an artificial protective device—the house. Indeed, one might argue that only the development of some form of shelter made possible the world-wide distribution of mankind that we see at present.

Aside from the physical shelter that a house provides, it also serves another universal need, the protection and storage of personal property. Although primitive man had few possessions and perhaps little need for storage unless he were fortunate to have an excess of game, man in his cultural advance soon began to acquire accouterments essential for his way of life and ornamental to it. These impedimenta, the personal assets we all treasure, must be kept and stored; they must be housed where they can be found when wanted; they must be set apart from the community property. If shelters and houses were not needed for man's physical well being, they would still be necessary to contain his equipment.

Indeed, when storage comes to occupy too large a space in the dwelling, man begins to build special houses to accommodate it. Food storage, especially in agricultural communities, requires this special housing, and in hunting groups such as the Eskimos special rooms or bays are built solely to accommodate reserve food and gear. Even in highly complex societies, like our own, this primary function of the house has remained intact, although with the necessity for large-scale storage of various commodities, special independent structures like warehouses and barns have evolved out of a province that once belonged exclusively to the house.

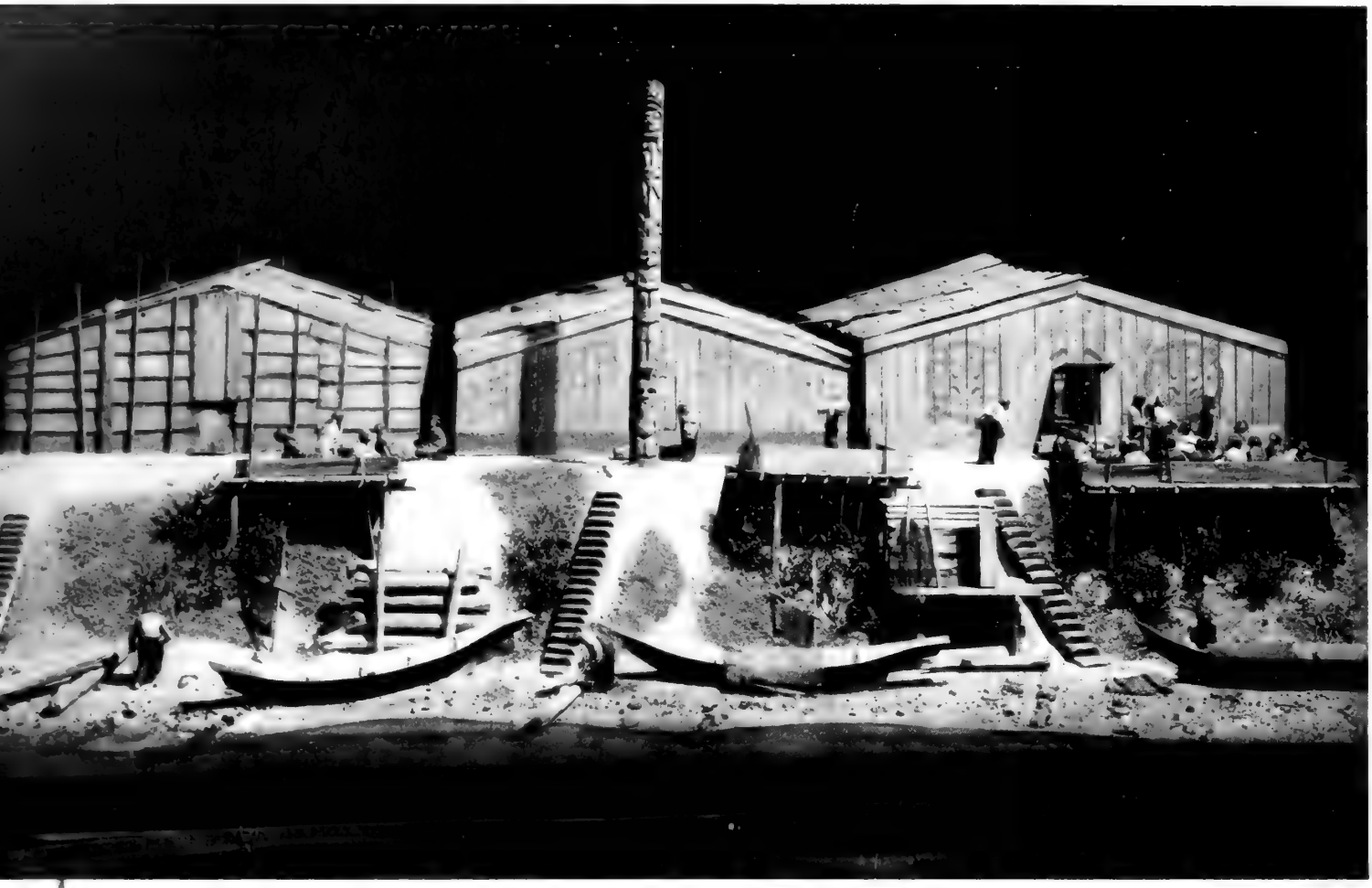
home as a refuge

To these basic requirements of the generic house may be added a less tangible attribute. The house or home represents a haven and a refuge. It provides an oasis of privacy in the midst of the publicity of community life. To have a room of one's own, a sanctuary, is a profound and common need. The child who discovers a secret cave where no one can find him, or builds for himself in the backyard a little shelter out of a packing case and stray lumber, into which he can retire as into a private world, reflects a profoundly human craving. It would be difficult, however, to determine whether such a feeling leads to building a house or follows from the possession of one.



➤ EVEN IN THE PRIMITIVE COMMUNITY, where each family seldom has more than one room, the home is a refuge and a haven, satisfying the human yearning for privacy. A Blackfoot tepee

▼ PRIVATE SLEEPING COMPARTMENTS provided seclusion in the earth-covered lodge of the Hidatsa Indians of North Dakota. The frame of one of these compartments without its skin covering is shown at lower right. One side of the lodge has been cut away in this model to show the interior. The only openings in such a house are the door and the smoke hole in the roof. Houses of similar construction were used by most of the semi-agricultural Indians of the Plains. The tepee was their temporary dwelling



▲ WHETHER ON AMERICA'S northwest coast as shown in this photograph, or elsewhere in the world, the plank-built house follows a certain general pattern. This is a village scene among the Kwakiutl Indians, reconstructed in miniature as an exhibit in the American Museum. Heavy cedar posts support the plank roof. In the older type of house (*at left*) the walls were made of overlapping planks tied to upright poles. The houses face the sea, and there are platforms in front on which the Indians pass much of the time in fair weather. These houses are decorated with elaborate carvings and paintings expressing mythological and totemic beliefs of the tribe

▼ USE OF GRASS as house-building material, widespread throughout tropical and some temperate regions, naturally imposes an architectural style quite different from that of the plank house. This is a model of a Congo hut

influence design

Although, as we have seen, the house has come into existence to serve simple and universal physical necessities, it has nevertheless acquired a vast and fascinating variety of forms, materials, and constructions. There seem to be almost as many kinds of houses as there are styles of clothing. Leaving out of consideration the complex houses of civilized man, I shall attempt to indicate the range of this diversity as it exists in the domestic architecture of the simpler cultures. And I shall try to indicate some of the factors and circumstances that dictate this variation.

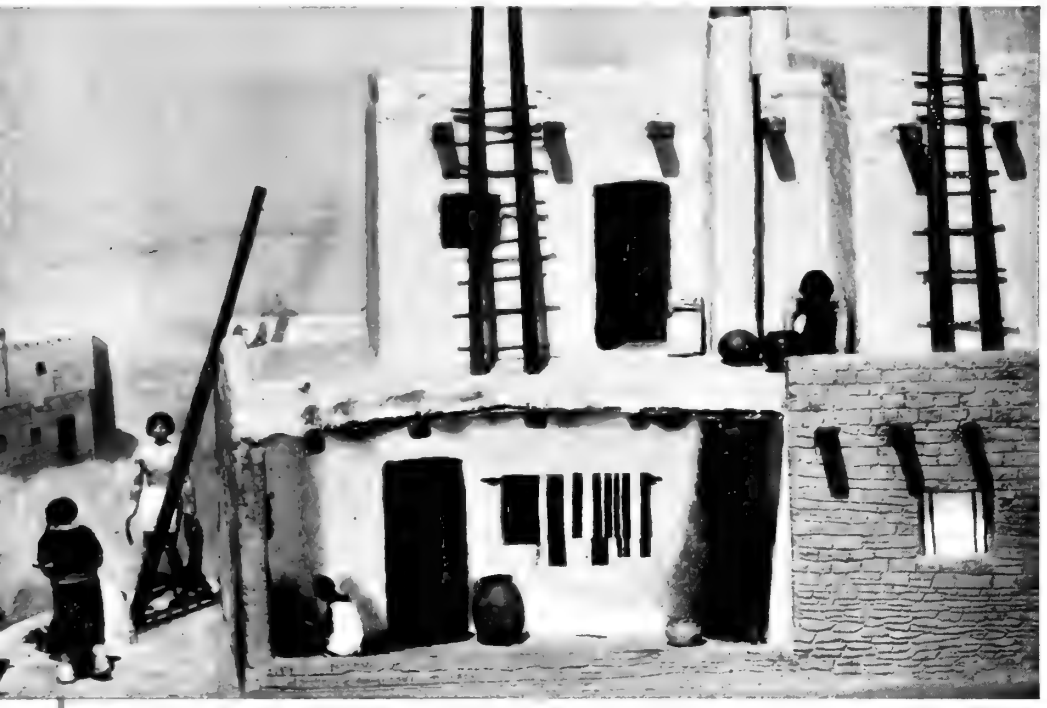
What is it, one may ask, that has brought about the multiplicity of domiciles even among people on a relatively simple level of culture? If indeed, the house is basically designed to serve such universally shared necessities as shelter, storage, and privacy. Moreover, if these needs are determining factors, why do the various forms of habitation not fall into a simple progressive line of increasingly perfect accommodation to them? There is no single answer to these questions, largely because these needs vary in their intensity and because the environments in which man lives are diverse. Moreover, numerous solutions are sometimes equally satisfactory even under uniform conditions. And finally, the creator of a house is a social creature, subject to a variety of influences emanating from tradition, knowledge, taste, and mode of life, which he embodies in all that he creates. It follows, therefore, that while the fundamental incentives to house building may be reduced to a few, the expressions to which they give rise may be and are many.

The material of which a house is constructed not only lends its character to the appearance and purpose of the structure, but it often dictates the method of construction. It is obvious that the use of planks and boards demands a framing quite different from the palm house. Furthermore, shapes that are feasible in one material are awkward in another. The circular, domed or conical forms, which are readily constructed out of fibers, leaves, grasses, or mud-covered wicker frames, are unsuited for wooden construction.

• Deep in the Ituri forest of Africa, the pygmy builds a small beehive hut of broad leaves. It sheds rain well but is tiny even for the diminutive people who build it. The hunter has just returned successful, as a result the hunting dog has been permitted to wear his wooden bell.

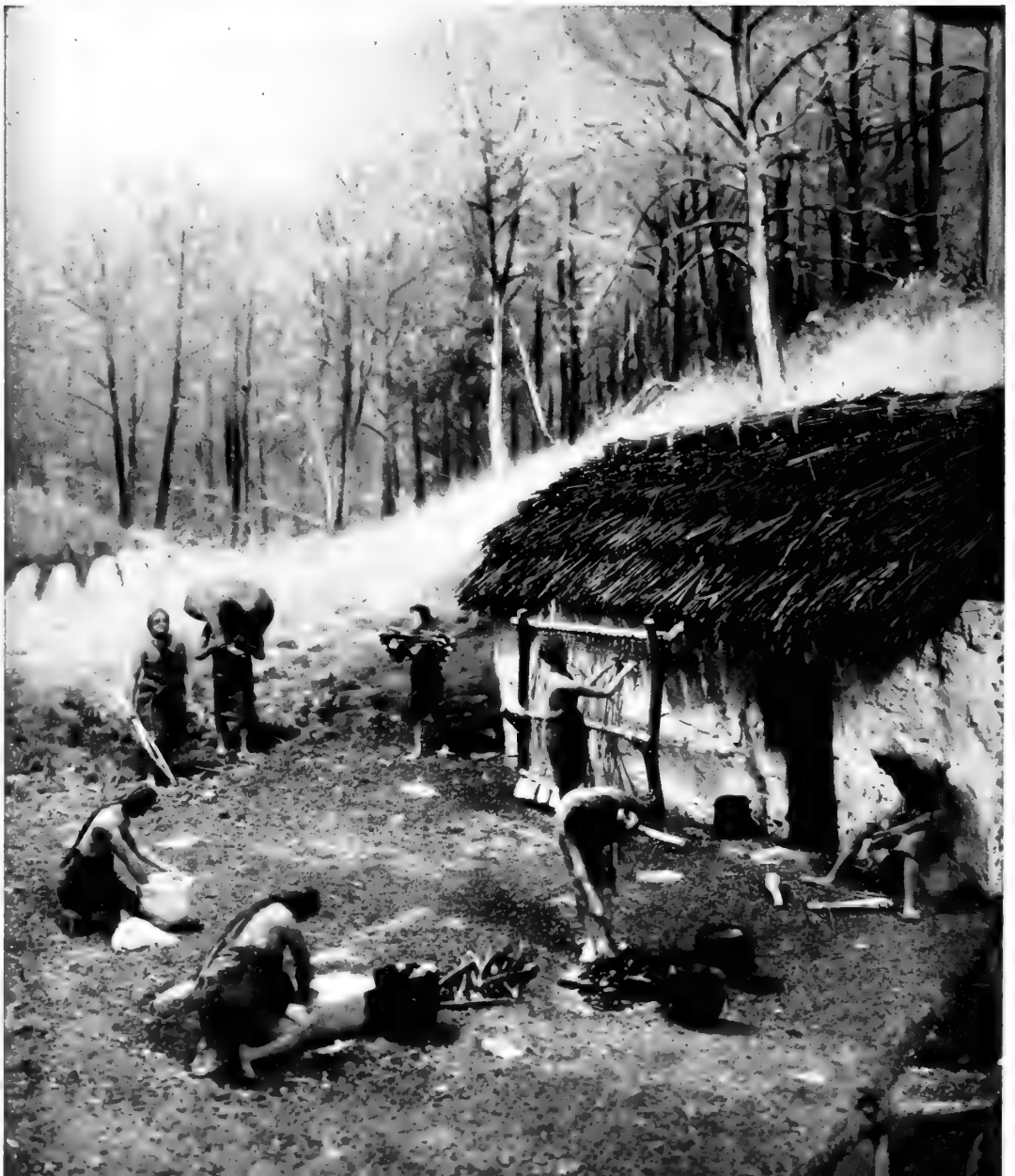
• A cut-away section of a model of a pack hut of the Ojibway Indian. It shows one of the basic patterns for a light hut, strong dwelling hut, the shape of a dome from materials widely available.

many different



stone and mud

◂ STONE AND SUN-DRIED BRICK, generally whitened with gypsum, are used in the construction of the compact Hopi village clusters. The women take an unusually active part in house-building, but the men are apt to lift into place the heavy beams, whose ends are seen projecting through the masonry in rows. The roofs are of cross poles, brush, and clay. Many of the rooms in the lower terrace are for storage



wattle and daub

▸ THATCH-COVERED wattle and daub houses like this are seen in various parts of Europe today, yet this is a model of a Neolithic house that was used in Denmark in about 2700 B.C.

materials

MAN has shown a remarkable ingenuity in his use of natural materials for building his shelters. He has employed stone, coral, brick (often in the form of sun-dried or adobe blocks), plaster, cement, mud, dung; loose, rammed, or root-bound earth; logs, planks, branches, vines, bark, leaves, reeds, grasses, skin, felt, mats, and even snow.

thatch and wattle

▲ THATCHING was tied over a frame like that of the Ojibway bark hut (shown previously) in the dwelling of the Shinnecock Indians of Long Island. Overlapping layers like this are remarkably effective in shedding rain

snow

◀ THE ESKIMOS build their snow huts by a totally different principle than that of other dome-shaped dwellings seen throughout the world. The blocks of snow are laid in a spiral. As the wall slopes inward toward the top each new block is supported by the one next to it. The Eskimo must travel light and is obliged to live at some seasons on the floating ice of the sea, where other materials are not available. His unique dwelling gives striking evidence that necessity is the mother of invention. It can be built in an hour, and all the builder needs is a snow-knife

skins

◀ SNOW HOUSES MELT with the approach of the warmer season, and the central Eskimos then live in skin tents. The poles are usually of driftwood

many different materials

birchbark

THE INDIANS of the Eastern Woodlands constructed a conical tent of birchbark almost the same in pattern as the skin-covered tepee of the Plains

THE LOG CABIN was originally neither Indian nor English. The idea was introduced by the Swedes who settled on Delaware Bay in 1638. The Indians of the South took it over and soon forgot they had ever lived in any other kind of shelter. This example is from the Yuchi Indians of Georgia. The log cabins built by the Indians had no chimney, only a smoke hole in the roof

logs

protection from . . .

It is difficult to generalize for all types of houses, but the environment generally guides the choice of material. This doesn't mean that building materials are uniform in similar environmental areas, although broad similarities do exist. It is rather that the environment tends to discourage the use of unsuitable stuff when more efficient material is at hand.

I may illustrate this by pointing out that in cold areas non-insulating materials are highly unsatisfactory, so that such climatic conditions tend to rule out at once the mat houses of the Philippines and the grass houses of Africa and South America.

This certainly is the tendency, although I must at the same time recall that the birchbark lodge of the Northeastern Indians and the lightly constructed Japanese house are not particularly well adapted to their environments. Perhaps stoicism and tradition in these cases rise superior to the discomforts of the weather. Conversely, in the hot moist climates, a heavily constructed and insulated house is less desirable than one of light construction with walls permeable to currents of air. As a result, not universal by any means, the tropic dwellers tend to build with grasses, palms, leaves, and other materials that permit ventilation while providing shelter from sun and rain.

Hot dry climates, on the contrary, call for thick walls, and again we see in the adobe house of the Southwest the selective power of the *milieu*.

cold

➤ MANY PEOPLE living in the Arctic build houses that are partly underground as protection from the low temperatures of winter. The example shown here is from the Maritime Koryak of eastern Siberia. A long passageway leads into the house, but in winter this is closed off and the house is entered through the smoke hole in the roof. The smoke hole is protected from drifting snow by a funnel-like platform. People in cold climates frequently sleep on platforms, because the warmer air rises

humidity

➤ ON THE TROPICAL HEADWATERS of the Amazon in northern Peru, the Chama Indians live in houses that are open on all sides to assure maximum ventilation in a hot climate. The roof sheds rain well but is also porous to air. These Indians do not sleep in a hammock like many others in the Amazon but upon mats spread on the floor. The house furniture is simple, but they strive to beautify everything they make

many protection

the

SHADE is found under this flat-topped shelter of the Apache Indians. A great problem here on the arid plain near the San Carlos River in Arizona, a roof is as good as a sloping one. In summer much time is passed by these Indians under this shelter, which is open to the breeze on two sides. For many generations the Indians have cultivated the fields of corn in this valley. The woman at left is applying melted pitch to a water basket; the man is making arrows

rain

◀SLOPING ROOFS OF THATCH, generally porous but water-tight, are characteristic of native houses in the tropics. So are raised floors and well-ventilated foundations. These and other typical aspects of life in the tropics are illustrated here in a model of a village in the Philippine Islands

from

sun

▼ THE FLAT ROOF OF DESERT REGIONS is seen again in this view of a model of the ancient city of Ur. So far as architecture is concerned, the climate here at the confluence of the Tigris and Euphrates is the same as that where the Apaches live—hot sun, dry air, and only slight rainfall. The flat roofs and mud construction, still predominant in the Near East today, would not withstand heavy rain. But they are admirably effective in dry climates where shade makes the difference between scorching heat and pleasant coolness

▼ LIVING IN THE SWAMPY EVERGLADES of Florida, the Seminoles have developed a house that gives the maximum protection against the effects of dampness below as well as above. Raised on posts and sheltered with thatching against the rain, the living quarters remain open to the drying breezes and thus are light and airy

damp earth

THERE'S NO PLACE LIKE

PART II

Mode of life and social organization influence house type: man's relations to the natural world and his concepts of society are reflected in his domestic architecture

HOUSING or shelter of some kind is a universal need. It provides man with necessary storage space for his gear and supplies, it surrounds him and his family with privacy, and especially it creates a climate which contributes to his comfort or enables him to live in areas which otherwise would be impossible for human habitation.

Man has developed an enormous variety of house forms and has utilized an astonishing number of materials. Not always, however, is the construction or the material the most suitable. In certain areas and circumstances the choice of a building material is limited by its accessibility. For example, the pioneers who settled the treeless plains of the Mississippi Valley found themselves without a local supply of the materials traditional for house building in the areas from which they migrated. Logs were unavailable or scarce. Stone or cut lumber meant a long expensive haul from the East. Sod, however, lay everywhere underfoot, available to anyone at the cost only of his own labor. As a result, the "soddy" or sod house became the common dwelling of the pioneer. Its form followed accustomed lines. It was rectangular with doors and windows and resembled, except for its material, the familiar cabin.

It is interesting and significant that these pioneers did not adopt a form of shelter already widely used in the very area where they were building their sod houses. The Indian tepee, built of skins stretched over a frame of poles, might have served as a model for newcomers, since skins were easily obtainable from the vast herds of bison and construction of the tepee presents few engineering difficulties. Despite its convenience, it was rejected, because the tepee is a relatively inefficient shelter against cold. Although its thin skin covering, pegged to the bare ground, sheds rain and snow well enough and provides a welcome shade in the summer sun, its insulating value in below zero weather is negligible. Its redeeming virtues were the ease with which it could be assembled or dismantled and its extreme portability. For the nomadic tribes of the Plains these were prime considerations. They were, however, of no value to settled agriculturists who expected to remain on their quarter sections and who welcomed permanence.

Under the circumstances, therefore, sod or earth were the only choice open to the pioneers, who solved their problem in a fashion not too dissimilar from the semisubterranean earth lodges of the more permanently settled Mandan and Arikara, who were also inhabitants of the Plains.

Where the circumstances are not as stringent as this, tradition may influence the choice of material, as may be seen from another example from our own architectural history. The first English settlers in New England brought with them from East Anglia a familiarity with wooden frame construction. They found in their new homeland an abundance of wood, as well as of stone and clay for bricks. Wood, it happens, was universally adopted in preference to the more permanent stone and brick, partly because the trees had to be felled anyway in clearing the land, but also because the settlers' knowledge of house building was based on wooden models in the old country. Thus, tradition was largely responsible for filling New England with wooden houses.

But farther south, the Dutch and Germans, who found a forest as abundant as in New England, preferred to build in brick and stone because they were already adept in the use of these materials in house construction. When the Western Reserve was made accessible for settlement, the New Englanders who migrated to this newly opened territory carried with them this already long established habit of home construction. In such early Ohio towns as Marietta, houses still stand that are faithful to the New England styles of the eighteenth century. Although time has changed the architectural detail, it would be interesting to know how much of the persistence of wooden frame construction in the United States today survives from the New England tradition established three hundred years ago.

Where the level of skill or culture declines, the influence of the environment becomes progressively ineffective in suggesting the best material or the most efficient construction. Thus we find the unfortunate inhabitants of the cold, raw land of Tierra del Fuego, who exist on a low level of culture, shivering behind their inadequate windbreaks, miserably protected from cold and wet.

All photos A.M.N.H.

▼ WINTER FINDS many natives confined to small, portable dwellings, prevented from using larger and more permanent shelter by the necessity of conserving heat and of moving in search of food. Here we see a camp of the Kutchin Indians on the upper Yukon in eastern Alaska as they

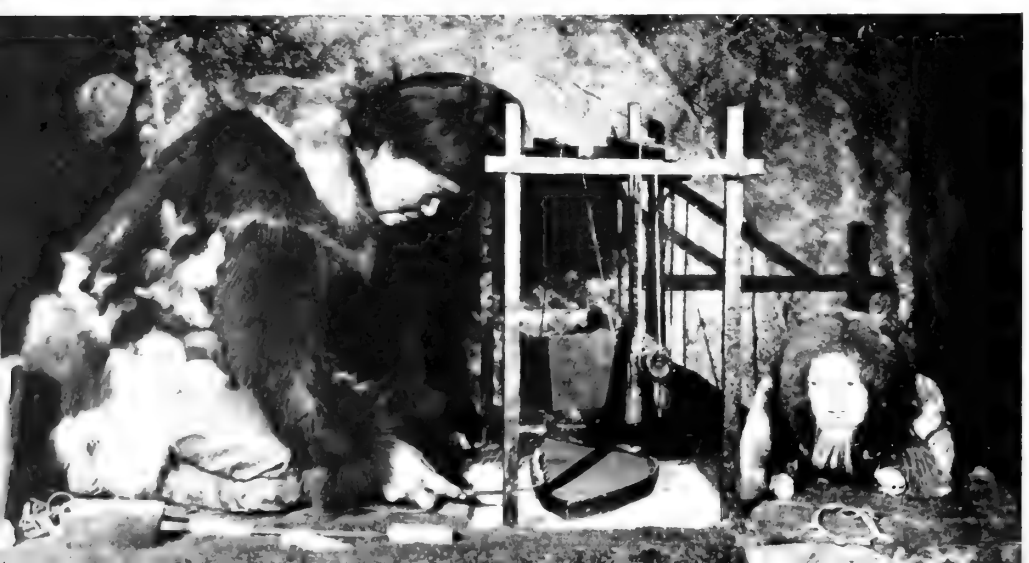
OME

e observed about 1850. The Arctic Circle
es through their country, and the winters
long and cold. The usual type of winter
se, as shown here, is dome-shaped, with
ed poles supporting a skin cover. Sleds
vn by dogs are in use, and hunting
fishing are the chief occupations

▲ A CRUDE WINDBREAK and the simplest of skin clothing constitute the only protection enjoyed by these Tehuelche in their chilly homeland near the southern tip of South America. Their tent, or toldo as it is called, is an interesting illustration of evolution in house design. Four centuries ago, at the time of Magellan's historic voyage, the Tehuelche lived in an even smaller and simpler shelter resembling that of their neighbors, the Onas (illustrated in the previous chapter). But, like some tribes in our own country, they soon learned to use the European horses, and by 1750 they had become a tribe of horsemen accustomed to treks through thousands of miles of country. This permitted them to carry this larger shelter. Notice that even the baby's cradle has been altered to fit across a pack load

▲ THE NECESSITY OF TRAVELING in search of food requires the Eskimo to move all his worldly belongings in winter on a sled. He has solved his house building problem so effectively that he needs to carry only a snow knife in order to construct a dwelling in which he can live comfortably for weeks or months

▲ A SHORT TUNNEL and protecting wall bar the doorway from bitter winds and provide shelter for the dogs. Illumination within is improved by a window of clear ice, here seen above the door

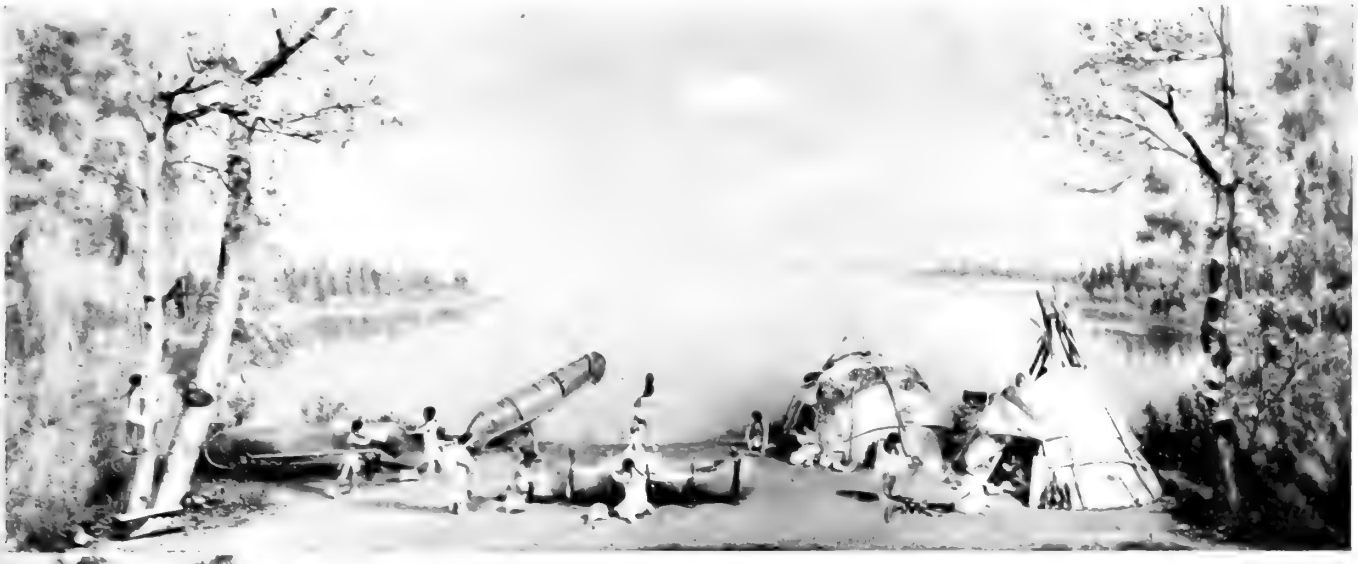


WHEN the natives are ingenious and skilful, we see remarkable adaptations to material and weather. The Eskimos' invention of the snowhouse illustrates how the ingenuity of skill can overcome the rigors of climate and the paucity of material to produce a satisfactory solution to a difficult problem. In this instance, the specifications are formidable. The Eskimos normally live in semisubterranean sod or stone houses, but certain groups who travel during winter and pass considerable time on the sea ice need another kind of house. Since the winter temperatures are extreme, this dwelling has to provide warmth and protection from the cold. Moreover, the material has to be something easily available, because the only method of transportation, the dog sled, rules out the possibility of carrying suitable building material. Skins or felt are inadequate to the conditions, and stone or wood are too heavy and cumbersome for building when speed is essential. Digging a semisubterranean shelter is impractical in winter even on land, for the earth lies solidly frozen beneath the snow, and of course impossible when traveling over the frozen seas.

Without some kind of an answer to this problem, winter travel would be out of the question, and hunting —a constant necessity for the Eskimo —would be dangerously limited. The genius of the Eskimo surmounted these obstacles in his invention of the snowhouse, which can be erected within an hour out of material everywhere at hand and in which he can live in comfort.

◀ THIS INTERIOR of an Eskimo snowhouse exhibited in the American Museum shows the skins that are sometimes pegged to the snow walls to give greater insulation from the cold. Eskimos frequently remove their upper garments in the snowhouse, because the temperature is brought well above freezing. The seal oil lamp that the woman is tending here is a shallow stone receptacle for blubber. The melted blubber burns through a moss wick

of the traveler



▲ RELIANCE UPON MATERIALS easily available has resulted in the elaborate use of birchbark by the roving Ojibway Indians. Note that two shapes of shelter are constructed with the same material, one dome-shaped, the other conical. In the center a birchbark canoe is being made, and at left an Indian is stripping the bark from a tree

◄ THE CREE INDIANS near Hudson Bay also use a tepee covered with birchbark. Sometimes caribou skin is used instead. These Indians make extensive use of rabbit skins for clothing, in the production of which the women shown here are engaged

► AS MANY AS SEVEN or eight persons live in one of these huts used by the Alacaluf Indians in an exceedingly rainy climate near the southern end of South America. Four sticks are put in the ground and bent over to form two parallel hoops. Other poles are then forced into the ground and bent across in the other direction, and lighter poles are added to complete the dome-shaped framework. Ten to twelve sea lion skins form the covering. The two doors at opposite sides are screened against the wind by fern fronds. A fire is built in the center of the hut and the occupants sleep at either end. When they travel to another location, they take only the skins with them

the permanent

▲ IN CONTRAST to people who follow a nomadic existence, those who pursue settled occupations such as farming are apt to be found living in permanent dwellings. Even in about 2700 B.C. the Neolithic people of Denmark are known to have erected substantial houses of wattle and daub, as illustrated in this model. The mound in the background was used for burial purposes

ome

ALTHOUGH the material may influence the design and structure of a house, it is not the only criterion by which houses are differentiated. The manner in which a building is employed may be as important as, or even more important than, the material itself.

The birchbark and the skin tepee, while differing in material, are essentially the same in structure and design. Similarly, stone or brick may be used interchangeably with little or no modification in the type of house itself. On the other hand, the same material may be applied to structures widely divergent in design. The domed shelters of the Winnebago, the tepees of the Ojibway and the Cree and the lodges of the Iroquois, despite their variety of shape, size, and construction, were all covered with bark. In distinguishing these abodes architecture is obviously more important than the nature of the covering spread over the skeleton of the building.

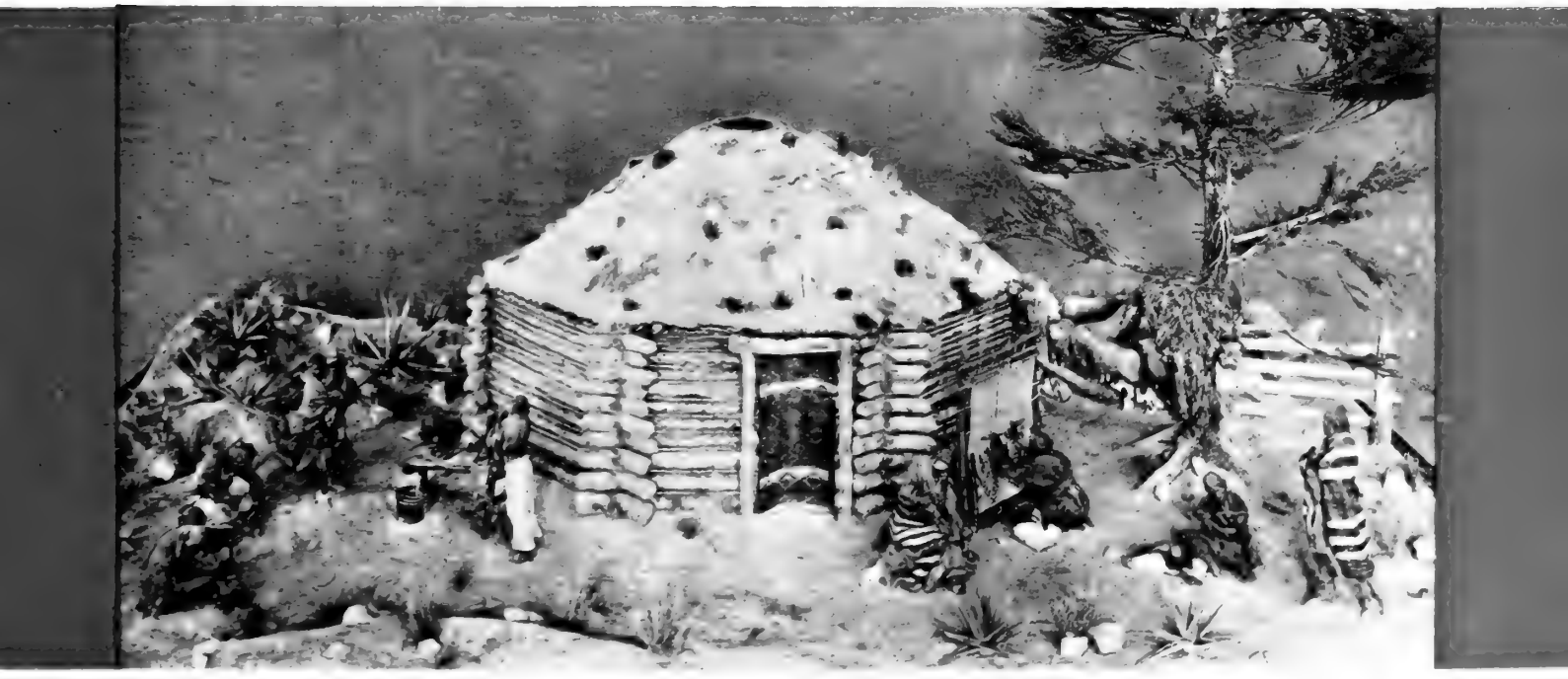
MOST of the house types among the uncivilized folk of the world are one-roomed affairs in which the high degree of room specialization familiar to us is absent. Here a single room contains most if not all the activities that we disperse among kitchen, bath room, dining room, living room, and bedroom, not to speak of the libraries, music rooms, game rooms, bars, offices, dens, studies, etc., of more elaborate establishments. The departures from the basic one-room plan and they are never very great, can usually be traced to specific circumstances in the life and environment of the inhabitants.

In warm climates, where the heating problem is not acute and the warmth generated by cooking need not be conserved, detached kitchens are often found. Where special structures are not put up, the cooking may even be done out of doors.

Agricultural people, who must store food in large quantities, frequently build for this purpose special storehouses or rooms as in the pueblos of the Southwest. But in general, a single room suffices, and may in cold regions be necessary in order to take advantage of every source of heat, artificial and human. Anyone who remembers an old-fashioned farm house in winter with its annual contraction of domestic life to a single room, usually the kitchen, can readily appreciate the advantage of the one-roomed dwelling.

◂ A GABLED HOUSE of bark is the home of the Sauk and Fox Indians west of Lake Michigan. Their elaborate use of basswood in the making of useful articles is illustrated in this model

▾ The Navajo Indians of Arizona and New Mexico build this characteristic log and mud house known as a hogan. Their life centers around the cultivation of corn and the tending of sheep, whose wool is woven into blankets as shown here



In more beneficent climates, sleeping quarters may be divided from the main room, and even special houses are sometimes erected where the young men of the village retire to sleep.

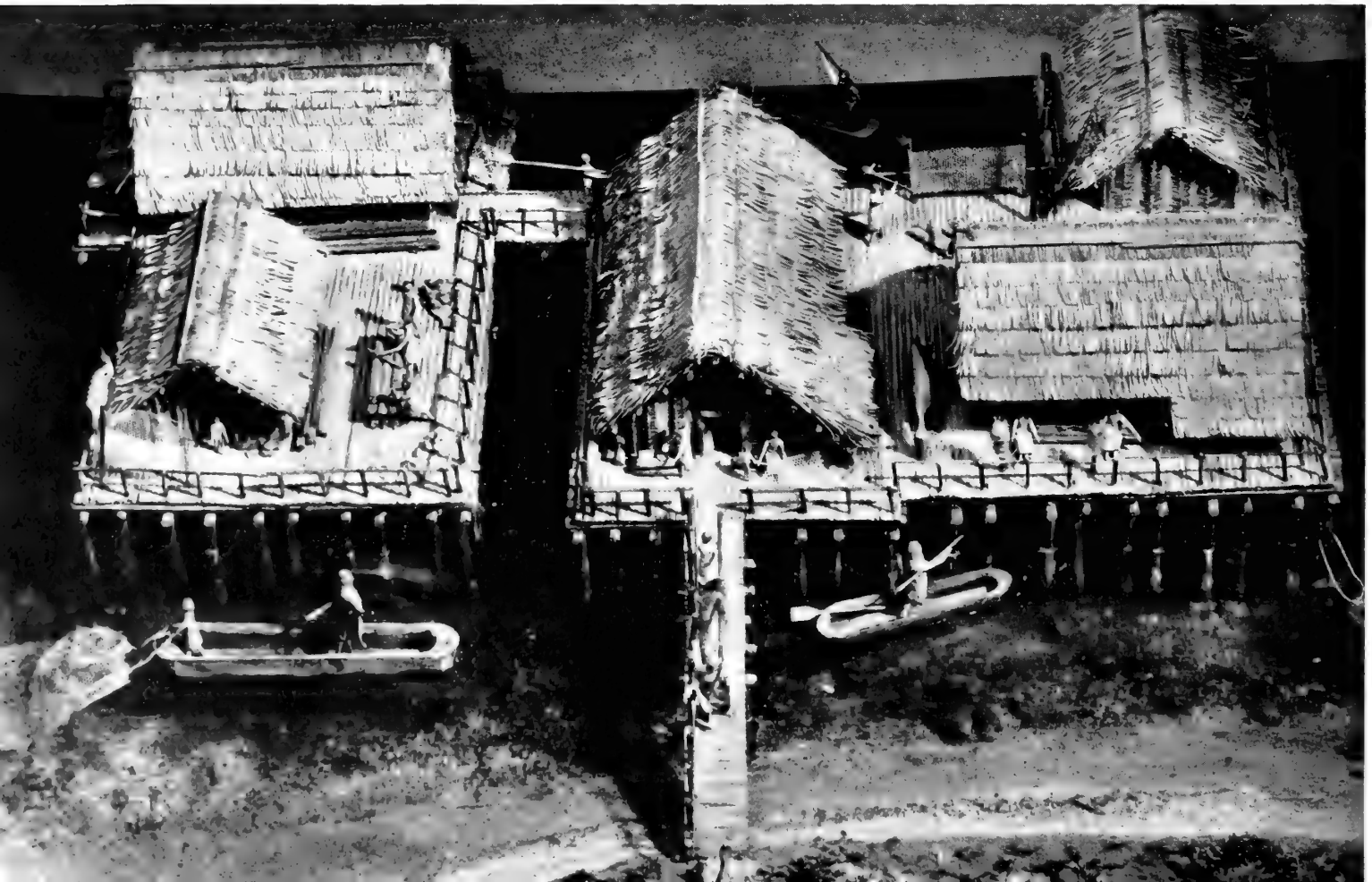
AMONG most people, the house is designed to accommodate a single family and is therefore small. These small units, however, have a definite relationship to each other. With the few exceptions to be mentioned, these units are detached but arranged in a village pattern, usually either along a street or in a circle. The latter arrangement, adopted by the Plains Indians, provides some protection against attack by hostile neighbors. Walls, too, are often an essential part of the village design either for defense or to enclose domestic animals. The famous kraals of southeast Africa were regularly surrounded by a stake fence within which the cattle could be confined. Walls to ensure family privacy are also known in rather more complex groups. The compound with its surrounding wall, found in Malay groups, is an example of this, and analogies to it exist in other parts of the world as well.

One of the most interesting village arrangements in aboriginal America is the pueblo of the Southwest. It is a single structure consisting of attached units all forming an apartment-house-like building, in contrast to most villages, where the family units are detached and separate. The pueblo takes several shapes but typically rises several stories, with each one set back from the one below it.

These examples of house plans and village arrangement are all drawn from social and familiar structures where each family inhabits its own private dwelling. Social custom, however, may decree a more intimate form of living. In such societies we find communal houses occupied by several families (such as the long house of the Iroquois) or even by the entire village where such groupings are small in size. The dwelling then becomes considerably expanded in order to shelter under one roof a relatively large number of people. The Iroquois long house was often from 50 to 100 feet in length, and the Haida built substantial communal structures 40 by 100 feet. Each family usually had its own recognized section of the large hall-like interior, where it might store its goods and possessions and where it could retire to sleep. Thus, social organization, mode of life, and climate tend to modify and control the house plan and the village arrangement.

community

▼ ARCHITECTURE and village plan usually reflect the community life of the people. Even as long ago as the time of the prehistoric Swiss lake dwellers we find an orderly arrangement of houses forming a well-knit social unit, as shown by this scientific reconstruction based on archaeological evidence. A narrow wooden causeway, easily defended against enemies, connects the village with the shore. The people belonged as much to the world of water as to that of land, but thei social life was circumscribed and conditioned by the narrow bound aries of their pile-supported village platform. A foundation so diffi cult to build would be expected to do for many generations



ife

▲ AN "ISLAND WORLD" of a different sort is embraced within the walls of the Hopi pueblo. Community life there fits into an environment of roof tops. These houses are built and owned by the community instead of by individuals or families. The woman at left is making a coiled basket; the one in the center is "building up" a pottery vessel by adding successive rounds of clay

▼ ON FIRST VIEW, the compact Hopi pueblo, accommodating many families on different levels, suggests certain resemblances to our city apartments. But its community life is much more intimate. Everyone knows everyone else, and the various roof levels, accessible only by ladder, interconnect with one another

UNQUESTIONABLY one of the most distinctive features in a house is its method of construction, by which I mean not only the manner of building the house but also its relationship to ground level, and its decorative features. If we include as houses all kinds of shelters, they may be classified into the following basic forms: open shelters (lean-to's and windbreaks), the circular house (either dome-shaped or conical), and the rectangular house with pitched or flat roof. Variations and elaborations of these typical forms are, of course, numerous. I have not included caves in this classification, because they are natural phenomena, exhibiting no evidence of human construction. A claim might of course be made for the artificial caves used by some of the Chinese or masonry-fronted caverns of southwestern Europe.

The open shelter may consist of a series of stakes or branches joined to form an open shell-like structure, covered with leaves, skins, earth, or some other suitable material. It may also be a simple wall to deflect the wind, or it may be a lean-to type where the wall is inclined to form a half roof. These devices, which are of the most primitive character, are nevertheless widely distributed. The Australian aboriginal often uses nothing more. The Apache of the Southwest sought protection behind a similar screen. I have seen natives in the Malay jungle bedded down under such an open-sided shelter that was covered with broad leaves as a kind of thatch. It is at best a makeshift and suitable only as a temporary lodging for nomadic people living in warm climates, where its ability to shed rain may justify it. To find such a poor protection in common use among the Ona of Tierra del Fuego, where cold wet winds are frequent, seems contrary to the rule that man adapts his shelter to fit the environment.

The circular and the rectangular house are fundamentally distinct in their structure. In the former the roof or covering is often a continuation of the walls, which must therefore slope inward. This type of construction simplifies the problem of the roof and renders the circular house a highly desirable form under certain circumstances. Some circular houses do, however, have distinct roofs with overhanging eaves. But this shape, of course, limits the size of the house, since too great a diameter would create engineering problems of considerable magnitude.

There are many variations in the basic plan: the beehive house found in Africa, the simple dome covered with skins or felt among the tribes of Northern Asia, and the classic tepee of North America. Fibers, grass, mats, and mud can generally be applied effectively as a covering, but other materials too are used. The skeleton is generally a simple one of poles, interlaced branches, or of horizontal members tied to uprights set into the ground. Among the Eskimos, where wood is often hard to come by, the native builder has sometimes used the curved jawbones of the whale for the frame, covering it with sod.

The rectangular house represents a more adaptable form of dwelling, since it allows greater floor space and more head room. At the same time, this type of house may be enlarged without overtaxing the architectural skill of the primitive builders and becomes, therefore, the preferred form where engineering knowledge has advanced but not yet reached the virtuosity required for large domed edifices. One of the major problems presented by the vertical wall is the break between the roof and the wall itself, which must be protected from leakage. In dry climates a flat roof is generally adequate, but in areas of abundant rain or snow, the roof must be pitched sufficiently to allow water to drain off rapidly. It is necessary, furthermore, to protect the top of the wall from absorbing moisture directly from the rain or from the runoff. The roof, therefore, becomes a cowl resting on the walls by means of a series of rafters, which meet along the ridge and project beyond the walls as eaves. This technical solution to the problem makes it possible for the builder to widen his dwelling, which he does at the expense of heavier wall construction, to support the increased weight of the roof. The simple pitched roof is by far the commonest form among these structures. Intersecting roofs with troublesome valleys at the junctions are never attempted by the primitive. The other two roof constructions in modern dwellings, the lip-roof and the mansard, are unknown. All the most highly evolved houses found among uncivilized natives belong to the rectangular category, and in such forms as the plank house of the Northwest coast or the elaborate houses of the Mernagkabau of the East Indies the architectural knowledge displayed is very impressive.

ALTHOUGH modern architects have become increasingly concerned with the relationship of house to terrain and have achieved novel and interesting adaptations to land contour, their purpose is largely esthetic. The primitive builder, on the contrary, builds his house in relation to the land on more practical considerations, but he manages in certain instances to achieve notably pleasing results. Not only does he build conventionally, resting his house directly on the ground; he also goes underground and above the ground.

The true underground house has no counterpart in modern domestic architecture, yet it is a most efficient manner of insulating a dwelling from cold by making use of the same principle that keeps our cellars warm in winter. It is a form of construction found only in the most rigorous climates. The classic type is the Koryak house of northeast Asia, but variations where the excavation is shallower are found among the Eskimo and among the prehistoric people of the Plains. In fact, the semisubterranean house has been traced over a large part of Eurasia and North America. It is possible that the subterranean ceremonial kiva, in which the Pueblo Indians perform their sacred religious rites, may be a survival of an underground house type once employed by their ancestors when they ranged farther north, just as our own religious architecture tends to preserve antique styles long abandoned for secular construction.

ELEVATING the house off the ground is achieved by primitive builders by means of stone platforms, by piles, or by building in the trees. The Marquesans, for example, set their dwellings on stone platforms which formed a terrace surrounding the house. The use of wooden piles for supporting a house is fairly common, the earliest known being the prehistoric pile dwellings in the Swiss lakes. Modern examples may be seen in tropical America and various Pacific Islands.

There are several reasons for adopting this method of construction. The most dramatic is the protection that a pile-dwelling, set in a lake, lagoon,

or along the shore, affords its inhabitants. Since a dwelling enclosed in such a natural moat cannot be approached on foot, a measure of safety is thus automatically assured. Some of the villages in the lagoons and along the shore of Melanesian Islands are said to have been built by people who formerly sought refuge there from their land-based enemies. Such a strategic retreat could prove a blessing for fisherfolk, who would find their source of food conveniently at hand.

Tree dwellers such as the Gaddang and Kalinga in Luzon and the Manobo and Mandaya in Mindanao set their dwellings as high as 40 to 60 feet in the branches of trees. These lofty eeyries provide an excellent protection from human enemies.

Pile dwellings, more prosaically, by raising the floor of the house above the ground also offer another kind of protection—relief from vermin, animal incursions, and the humid exhalations of damp village sites. Native housekeepers find their superior elevation a convenience in their domestic tasks, since garbage may be easily disposed of below the house where the scavenging pigs of the village have free access.

protection from enemies

▼ **Tree dwellers** in the Philippines build their houses as high as 40 to 60 feet above the ground and thus secure excellent protection from human enemies. This is a full-size model on exhibit in the American Museum of Natural History

protection from enemies

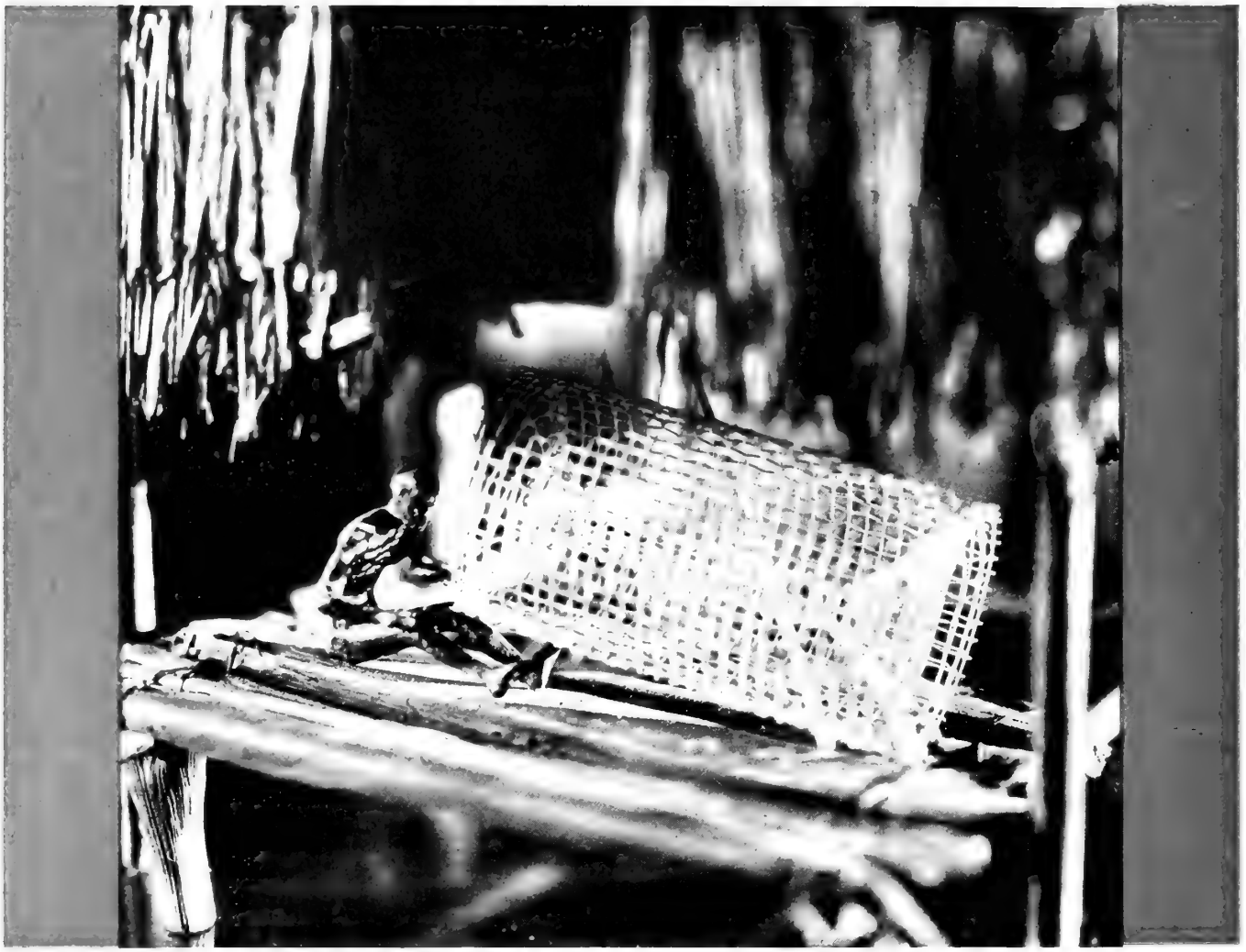
▼ PROTECTION AGAINST ENEMIES was attained to an extraordinary degree by the builders of the cliff dwellings in Southwestern United States. Extremely long ladders were sometimes the only avenue of approach. Protection from the rain was usually given by the overhanging cliff above. The stone and adobe buildings were plastered in a color closely resembling that of the surrounding cliffs. This model is a replica of a cliff village in the Canyon de Chelly in northeastern Arizona

▼ The Zulus of Africa protect their cattle within a double circle of fencing, with the village huts occupying a unique position between the two rings

▲ THIS MODEL OF A VILLAGE of the Manus tribe in the Admiralty Islands is a beautifully executed example of house design showing the community life of a people who dwell over the water. For all the necessities of life, these people depend upon their skill in fishing and in navigating their large outrigger canoes. They trade fish for vegetable food and for wood for their houses and canoes. Note that the natives have painstakingly built up in the sea a small island of coral rubble to serve as a "town hall," where important meetings take place. Elaborate feasts connected with marriage, birth, and death enliven their isolated community life

a village over a lagoon

▼ THE PEOPLE OF THE MANUS tribe make voyages to distant islands in sailing canoes like the one reproduced here in miniature. A cargo of pots is being brought as a handsome gift to the kindred of a young man who is about to be married. His relatives have already paid many hundreds of dogs' teeth to signalize the marriage

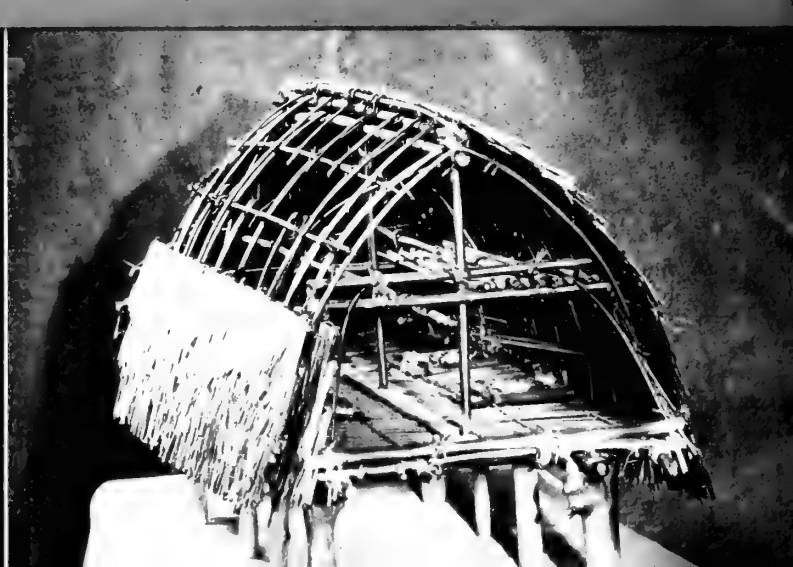


▲ A DETAIL VIEW from the model of the Manus village showing the construction of a cylindrical fish trap. Many important phases of the life of the people are shown within the single model. Such an exhibit is possible only after many months of scientific study among the people. The investigator may have to learn to speak the native language in order to secure all the necessary information. In addition photographs and drawings aid the Museum's technician in reconstructing such a model

▼ EVERY OPERATION in building the full-size house is performed by the model maker, who thus produces in miniature an exact scientific replica of the original

▲ IN THIS INSTANCE, before the model house is completed its inhabitants must be put inside, because one is intended to see them busy at their daily tasks through an opening left in the roof

▶ THUS, THROUGH the blackened rafters one sees the woman of the house preparing a meal of fish



A SCRUPULOUS attention to detail is observed in every stroke of the knife in fashioning the smaller objects for one of these models, in this case an outrigger canoe, identical except in size with those used by the Manus tribe

WHATEVER beauty most types of native houses possess is functional and accidental. It springs from the quality of material employed and the surface it lends, from the shape and mass of the house itself, and from the structural details of the building. The esthetic distinction not infrequently evident in these simple houses does not represent a conscious striving for an effect; it is the natural result of the construction.

I recall vividly the pleasing effect which the under side of a thatched roof produced in the interior of a Polynesian house in which I once lived. The steep, lofty rafters, completely exposed from below, were covered by overlapping layers of thatch, narrowly spaced. This simple, functional finish was perfect in itself and needed no further adornment.

In a few noticeable instances, how-

ever, the native builder does consciously attempt to enhance the beauty of his work by additional details that have no purpose save to enrich the architecture. The Maori of New Zealand elaborately carved the gables of his house with fine scroll and openwork inlaid with shell, and he frames the doorway with similar decorations. Carved and painted designs of great elaboration are used by the Tlingit and Haida to embellish their houses. House decoration reaches a very high level in the East Indies, where carved and decorative elements are frequently incorporated into the façade and gracefully curving roof lines, and where telescoped gables and sweeping eaves are exaggerated for their esthetic values.

Some of the most interesting examples of primitive house decoration are the molded walls of African mud houses. The plasticity of this material lends itself particularly well to the vivid fancy of the African natives, who often achieve very striking effects by simple means.

The house, however humble, embodies and reflects so much of our history, our traditions, our skill and culture; it speaks so eloquently of our opportunities and our failures that one can't help agreeing that where'er we may roam,—"there's no place like home."

▼ The natives of New Zealand, the Maoris, spared no pains in applying their high skill as wood carvers in the decoration of their houses. The style of decoration in which they have distinguished themselves is illustrated here by one of their carved food storehouses, on exhibition in the American Museum of Natural History

OTHER PUBLICATIONS ON Peoples of the World

Order any of these items from Man and Nature Publications, The American Museum of Natural History, Central Park West at 79th Street, New York 24, New York. They are all published by the American Museum

PEOPLES OF THE PHILIPPINES. By A. L. KROEBER. *244 pages, 50 illustrations. Cloth bound. Second edition, revised. 1943. Price, $1.00; postage, 7 cents.*

This comprehensive handbook on a region that has become increasingly important in recent years should prove useful to men in the service and to students of anthropology, as well as to the casual reader. It presents an interesting account of the racial and cultural background of the islands and discusses the art, occupations, and religion of the natives. It is a valuable aid to the visitor in the Philippine section of the Museum, whose collections provide illustrations for many of the subjects presented.

THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By ALANSON SKINNER. *64 pages, 27 illustrations. Paper bound. Fifth edition. 1932. Price, 20 cents; postage, 3 cents.*

Few subjects make a more forceful appeal to the student, historian, or even the general reader, than the native Americans who occupied what is now Greater New York. Yet it is very difficult to obtain information on them, for the few accounts which the Colonists left us are in tomes that are rare and difficult of access. This booklet briefly supplies the available information, discussing the life of the natives, their costume, religion, and archaeology.

PEOPLES OF THE PACIFIC. By HARRY L. SHAPIRO. *15 pages, 41 illustrations. Paper bound. 1945. Price, 25 cents; postage, 3 cents.*

This booklet serves to introduce the reader to a wide variety of types of people and their equally diverse and interesting cultures. It is profusely illustrated with beautiful photographs and has an excellent series of maps showing the waves of migration that populated the various sections of the Pacific.

INDIANS OF THE NORTHWEST COAST. By PLINY EARLE GODDARD. *175 pages, 103 illustrations. Cloth bound. Second edition. 1934. Price, $1.00; postage, 7 cents.*

This plainly written account relating to the work and exhibits of the Northwest Coast Indians Hall in the American Museum is valuable not only to the visitor wishing additional information but also to anyone interested in the Indians of this area. It discusses the topography and climate of the territory along the coast from the Columbia River in Washington to southern Alaska, as well as the customs, religion, and art of its inhabitants, expert workers in wood and carvers of totem poles.

NORTH AMERICAN INDIANS OF THE PLAINS. By CLARK WISSLER. *172 pages, 64 illustrations. Cloth bound. Third edition. 1941. Price, $1.00; postage, 7 cents.*

This well illustrated and clearly written handbook is a summary of the facts and interpretations of the culture of the Plains Indians. It serves as a guide to the American Museum's collections and will give the visitor a broader understanding of the materials on display. Further, it acquaints the student and general reader with many of the basic points in the study of this North American Indian culture, including marriage, social and political organizations, and language.

INDIANS OF THE SOUTHWEST. By PLINY EARLE GODDARD. *205 pages, 71 illustrations. Cloth bound. Fourth edition. 1931. Price, $1.00; postage, 7 cents.*

This book will be useful not only to the Museum visitor who desires more information about the subjects illustrated by the collections in the Hall of Southwest Indians, but also to the student of American history and culture. It offers a review of the facts concerning both the prehistoric and historic natives of our Southwest. Among the subjects treated are the Spanish conquest, the Pueblo and Village Dwellers, the nomadic peoples, cliff dwellers, native weaving, the potter's art, and the Hopi Snake-Dance and other ceremonies.

A WORLD FULL OF PEOPLE

THE FACTS OF POPULATION

By HARRY L. SHAPIRO

Chairman of the Department of Anthropology,
The American Museum of Natural History

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THE AMERICAN MUSEUM OF NATURAL HISTORY

A World full of people

By HARRY L. SHAPIRO*
Chairman of the Department of Anthropology, The American Museum of Natural History

The facts of population are vital to every nation and to the international adjustments of the world. Here the basic principles and their significance are discussed in non-technical language

For who can count the multitude of men?
They are like grains of sand.
And who can know their diverse nature and condition,
From the most base to the most exalted?

PEOPLE are the most valuable of natural resources—and the most universal. Perhaps this very ubiquity, together with mankind's propensity to replenish itself with little or no encouragement, accounts for the tendency in many quarters to take population for granted. Indeed, it is probably fair to say that the existence of any problem in this connection would have seemed novel a few centuries ago. If any problem existed then, it was apt to be merely one of stemming the flood of mankind that threatened the available means of subsistence.

We have, however, become aware in recent times that there is more to population than its mere size or its growth, important as these are in a national economy. Population, we now recognize, has a complex structure, with a dynamic balance between the component elements. Alterations in one of these elements, can lead to significant changes in the whole. But more than these quantitative aspects of numbers and rates, population has a qualitative side. Two populations of equal size and of similar age structure may yet be vastly different in biological fitness. This is a phase of population much less known or understood, but obviously one of the utmost importance. To study the behavior of aggregates of people, how they maintain their size, why they increase or decline; to analyze such aggregates into their significant elements and to determine their mutual adjustments; to ascertain if such aggregates are improving or degenerating in quality —these are the aims of the biology of population. It is a subject of the greatest practicality for the welfare of a nation.

A population is the total number of individuals who may be embraced within a given classification. Thus we may speak of a school population, the population of New York City, the male population, or the population of the United States. Statistically considered, these populations may be described by various mathematical devices, and, when chronology or comparison with similar groups is added, we may deduce from such mathematical summations certain trends and tendencies. Because all the units or subdivisions of a nation are influenced far more by each other than any one is by similar units in other nations; because intermixture is more common within national boundaries than across them; because the national destiny combines all the subdivisions into a kind of biological as well as cultural, political or economic entity, we have come to think of the total national population as a biological expression susceptible to scientific study and analysis.

I have frequently speculated a little on the origin and evolution of our

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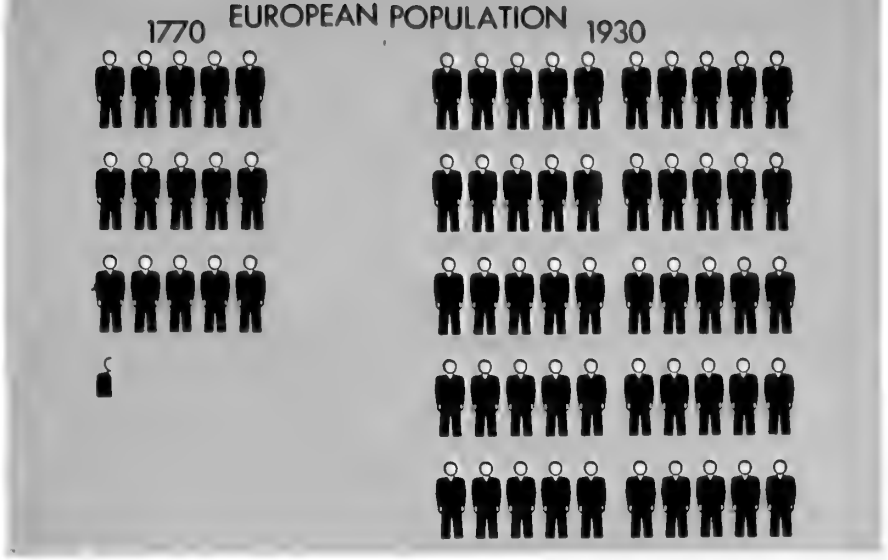
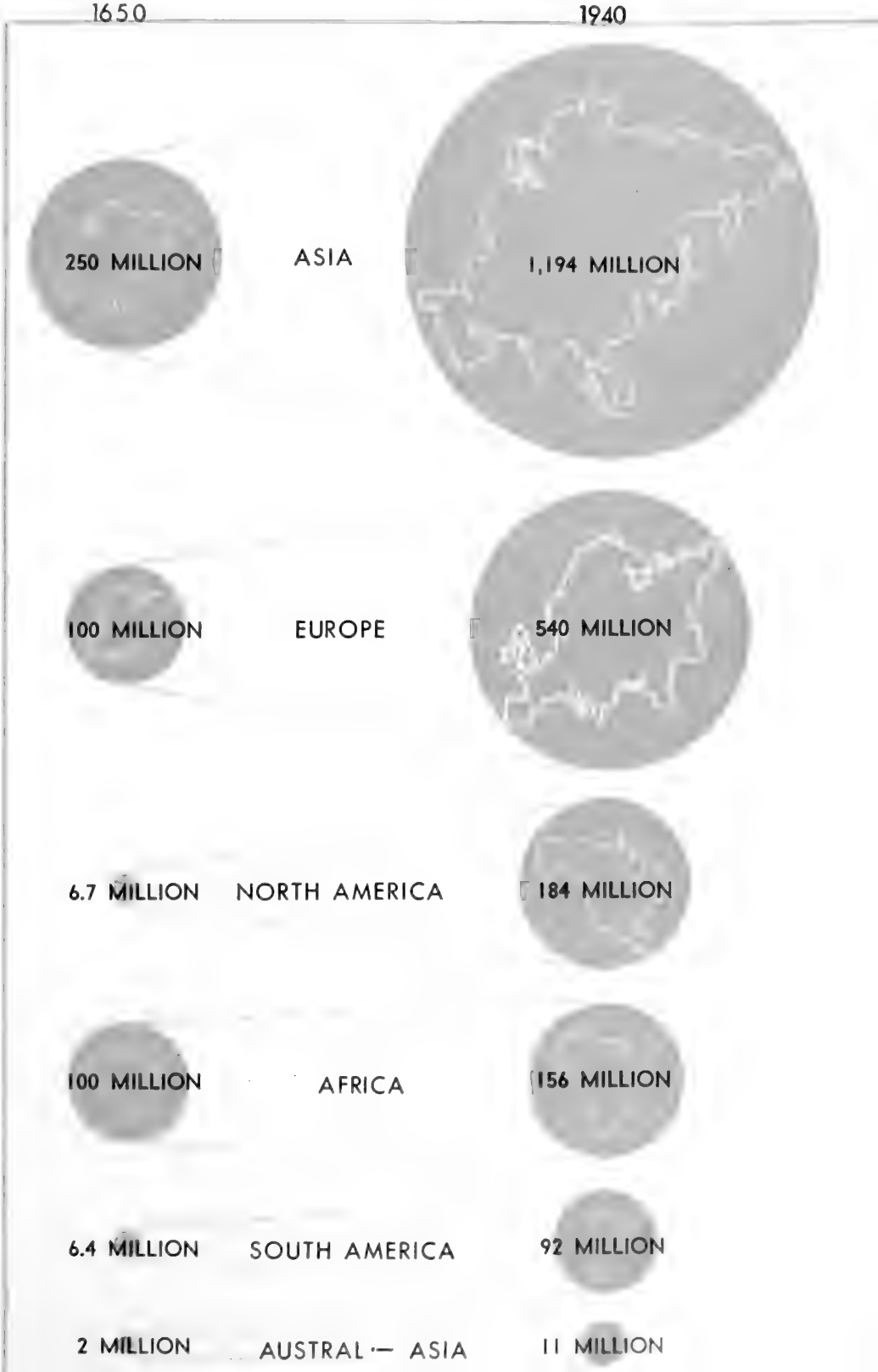
He has done field work in the West Indies, our own Southwest, China, Japan, and Alaska, and has been on a number of expeditions to the Pacific, particularly to Polynesia. Dr. Shapiro's particular interest is physical anthropology, and he has done much research work in this field and on such related subjects as race mixture, population, etc. His publications include *Heritage of the Bounty, Migration and Environment,* and numerous articles and papers, both scientific and popular. He is active in several scientific societies.

Since 1942 Dr. Shapiro has been Chairman of the Department of Anthropology of the American Museum, where he has worked since 1926. He is also Professor of Anthropology at Columbia University and Associate on the Staff of the Bishop Museum in Honolulu.—ED.



▸ RAPID GROWTH of population due to industrial development, lowered death rate, and the development of resources in the New World

interest in the biology of population, and it seems to me that much of it has been stimulated by the accumulation of data provided by the census. Before the notion of census taking became an established function of national governments, little if any attention was directed toward the study of population as population. What enumerations were in existence were outgrowths of other concerns. Tax lists had to be drawn up, or man power resources for military uses had to be mapped. Enumerations of people also had value for the church and were significant for various political and economic purposes. But these counts were never primarily instituted for biological reasons and were rarely employed for such ends. Although they go far back in recorded history, they were with few exceptions, desultory and unsystematic. Not until fairly recent times did the notion become established that periodic and systematic enumerations of the population are valuable and necessary enough to warrant their being a fixed function of the government. The earliest official census, as distinct from estimates, seems to have been initiated in New France in North America and was continued there from 1665 to 1754. The United States was among the first of modern nations to establish, in 1790, a regular census repeated at fixed intervals. Its purpose was primarily political, since it was designed to serve as a basis for representation in Congress. Great Britain began periodic enumerations in 1801; and by the end of the nineteenth century, the economic and political necessity of census taking was recognized in most civilized countries in the world. The necessary organization, however, for an accurate census in a large country still proves a stumbling block for many governments, with the result that even official national censuses vary widely in their reliability from country to country. But whatever the origin of the census



▸ GROWTH OF POPULATION BY CONTINENTS. Note that the increase has been much greater in some continents than in others and that the distribution of population throughout the world is quite different than it was a few centuries ago

may have been—political, economic or military,—the study of population problems proved to be one of its unforeseen and most valuable by-products.

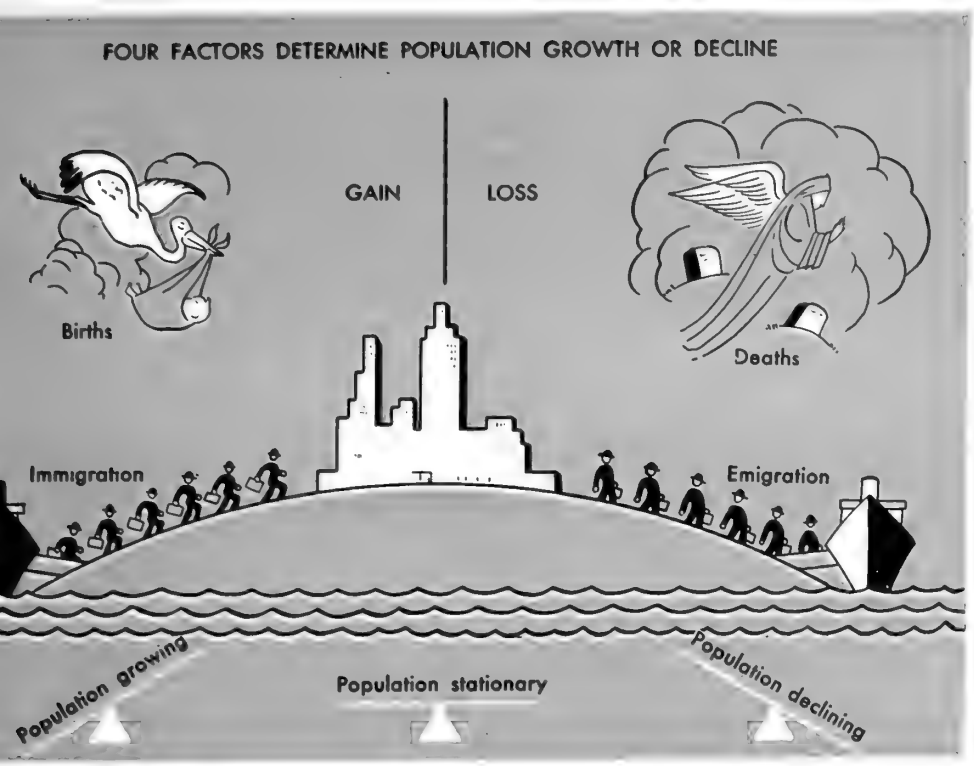
Since the first censuses provided little more than total counts, the pioneer students were restricted, by the very data available, to the problem of the total growth of national populations. It happened, however, that the trends revealed by these initial enumerations were startling enough to warrant serious thought. As early as 1755 Benjamin Franklin was commenting that the population of the United States was doubling every 25 years, and by the end of the eighteenth century Malthus already had enough available data to be impressed by the dangers of a population growing beyond its means of subsistence. How rapidly various European nations were growing may be seen by comparing Europe's population in 1770 and 1930. In 1770 it was 152,500,000; 160 years later it had increased to about 500,000,000—something like 3 times. This remarkable expansion seems to have begun in Western Europe and to have gradually spread throughout the continent. In America the rate of growth was even more rapid than this, as it also was in the British colonies in New Zealand and Australia.

The phenomenon was so widespread and so decisive that at first expansion was assumed to be the natural condition of all populations, and alarm was frequently expressed for a future in which a world bursting with people would find its means of subsistence inadequate to support them. We now know that this increase was merely one phase of the world's population history and that expansions on this scale had never occurred before. Indeed, a little arithmetic demonstrates how unlikely it is that populations in the past have grown at a rate anywhere near their full reproductive possibilities. If, for example, reproduction were uncontrolled, a woman could give birth to 5 or 6 children betwen her 17th and 27th year. If 4 of the children survived and reproduced in their turn at the same rate, the population would double every 27 years. But this is not the highest rate possible by any means. If a woman survived to her 35th year, she could easily bear 8 or 9 children. With only 6 offspring surviving, the population would triple every 35 years. Thus a single couple reproducing at the first rate would yield in 540 years, 2,097,000 descendants, and at the second 45,956,000. In 1080 years the respective number of descendants from one husband and wife would reach 2199 billion and 1,656,000 billion. Obviously, then, mankind has not been increasing at anywhere near its full potential. And the acceleration in recent centuries cannot have been going on for very long. If we project backward the modern population of Europe, reducing it by the same rate that it has increased over the past 160 years, we would find ourselves in an empty Europe at the beginning of the Christian era.

When we recall that man is estimated to have an antiquity of about one million years, it is obvious that he has neither increased steadily nor at his full capacity. Over much of this period the human population must have remained static or even retrogressed. Although statistical evidence of this nature does not exist for mankind's early history, we have some fragmentary evidence to prove that populations are not forever expanding.

Japan, for instance, had a population of 28.1 millions in 1721, and 135 years later her population was roughly the same (28.9 millions). Spain, in the seventeenth century, had passed beyond one growth phase and was in a state of decline, a circumstance rarely mentioned in connection with her political decline and her colonial policies.

Why is it then that populations increase, decrease, or remain static? There are various reasons given, but let us first examine the direct mechanism by which the process itself is controlled. There are four functions whose mutual adjustments determine the curve of a population. These are birth rate, death rate, immigration, and emigration. By the rates of these and by these alone is the size of a population determined. The differential between birth rate and death rate

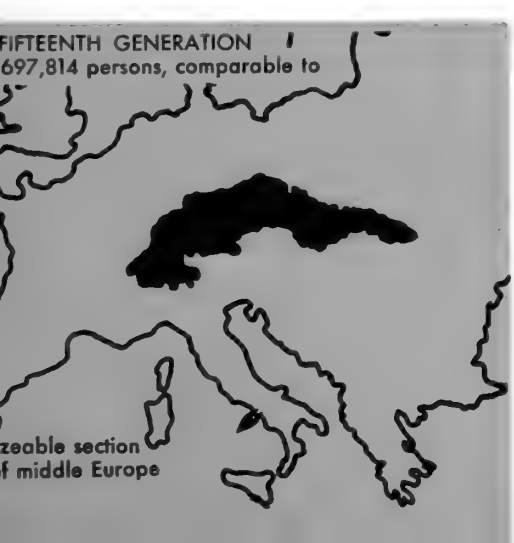


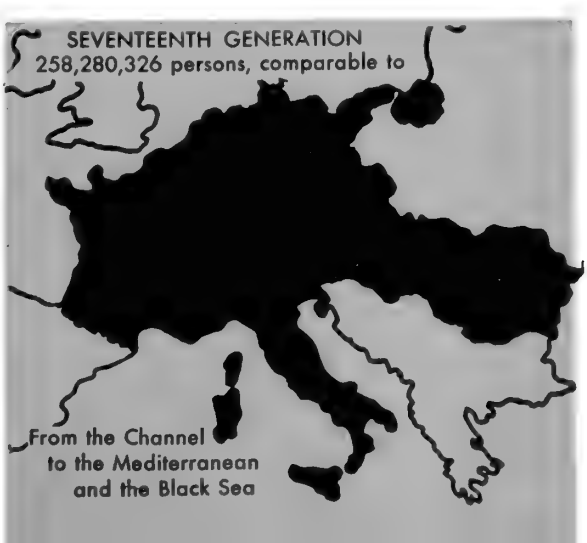
gives us the natural increase or decrease—the amount by which a population, by the success or failure of its own efforts, is adding to its numbers or losing them. Ordinarily birth rate and death rate alone are the decisive factors, but under certain circumstances the displacement of population from one country to another may strengthen the national trend of a population or counteract it. Immigration to the United States during most of its history was a significantly positive contribution to its remarkable growth. Ireland during the famine years was unable to replace by its own natural increase the losses suffered by emigration. France in recent years has sought to redress her unfavorable balance betwen births and deaths by permitting the immigration of Italians and Poles. But in most countries, and during most of the time, the balance of births and deaths determines the issue.

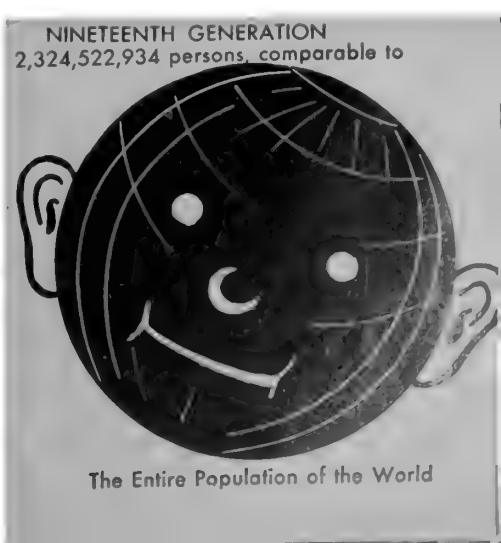
Natural increase is achieved when the birth rate surpasses the death rate, and the greater the difference the larger the increase. But birth rate need not be increased to attain this favorable balance, it may be accomplished by a decline in the death rate. Where both rates are changing the natural increase will be proportional to the relationship between them. During the past century the birth rate of western Europe was dropping steadily, but the natural increase was maintained because the death rate was also dropping and in some cases more rapidly than the birth rate. Since the drop in death rate has slowed down and the drop in the birth rate threatens to approach it, the natural increase is shrinking away. It is apparent, therefore, that an explanation of why populations increase or decrease must be based on the factors that govern not only the birth rate but also the death rate and the balance between the two.

Among the variables that one might expect to be most effective in determining differences in birth rate is innate fertility. We are so accustomed to having the high birth rates of the Japanese or the Russians or the Southeast Europeans contrasted with the dwindling families of the French, English, and Americans that almost insensibly we come to assume a difference in fertility. Similarly we are apt to attribute a greater power of reproduction to primitive people than to the highly civilized. Some authorities, however, deny that any real distinctions can be drawn between the various races or peoples of the earth in this respect. They maintain that unhampered reproductive rates are approximately the same for all mankind, somewhere between 40 and 50 per thousand, and that whatever deviations occur are attributable to inhibiting factors. For all practical purposes, according to this view, we may neglect any possible variation in innate fertility and speak only of limiting circumstances. The following chart, based on figures published by Raymond Pearl, supports this contention, but it should be stressed that the available data are by no means adequate for a universal generalization. Sterility, however, in so far as it lowers the average fertility of a population does seem to occur more frequently in highly civilized societies than in primitive ones.

Leaving aside therefore the question of any inherent differences in reproductive powers, there are two principal sets of limiting influences on birth rates. One is social and long term, the other is catastrophic and short-lived. A study of primitive as well as civilized sex customs reveals a diversified series of habits and rites that limit in varying degree the natural fertility. Sexual taboos of diverse descriptions, for example, are commonly practiced among primitive people. Sexual intercourse may be forbidden before ceremonial occasions, before battle, for ritual reasons, and for varying periods in connection with menstruation. In extreme forms, a woman may actually be excluded from the possibility of reproduction during half her child-bearing period. The custom among certain primitive







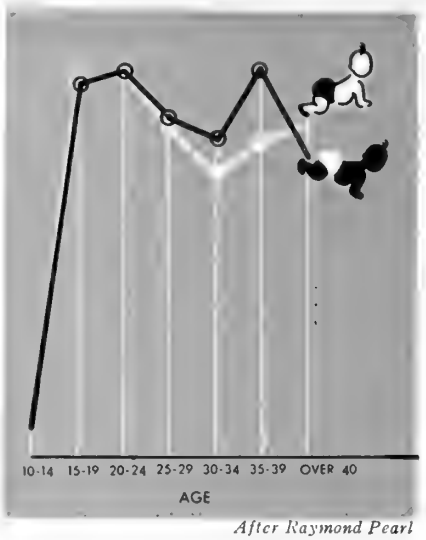
women of nursing children for an extended time tends to reduce the chances of conception, and in fact the practice is deliberate with many of them who desire to keep their offspring at a minimum. It has been reported that some primitive groups who cultivate this device keep their children down to 4 or 5 per woman.

Abortion is by no means universally accepted, of course, as a method of birth control; nevertheless it is commonly practiced in many societies, our own not excepted. How effective or how extensive a method it is we do not know, since accurate information is lacking. Certainly in most primitive societies knowledge of it is widely disseminated, and inquiry readily elicits specific details of procedure as though recourse to it were frequent enough. Estimates for a city such as New York run into colossal figures. One estimate suggests that as many conceptions terminate in abortions as in live births. There can be little doubt that this method of limiting births is one of the most significant in human history.

Another method of reducing the population if not the actual birth rate is by infanticide. This resource is to our minds a revolting practice, yet in certain countries it has been adopted and has received social approval or at least tacit tolerance. It is apt to occur where the pressure of population has become a serious problem. In Tahiti, for example, Captain Cook found the natives openly abandoning female children to exposure and death. The teeming population confined within its narrow island presumably could not expand further and the excess had to perish. Those who doubt Malthus have here an object lesson on the reality of population pressure. China, too, has countenanced female infanticide, and in times of stress its practice increases. So common a thing is it in China that its profound results may be read in the marked excess of males over females ranging from 10% to 50%.

Less direct than these is the effect of various other by-products of social custom. Among them I might mention the increasing age at marriage which, at least until very recently, was evident in highly civilized societies. Economic causes are generally assigned to the tendency to delay marriage among us, but in at least one primitive group with which I am familiar this delay arises from a gerontocracy where the old men are dominant and pre-empt most of the young maidens for themselves, leaving the young men to make the best they can of the old ones or wait for their turn with advancing years. The tendency to delay marriage, other things being equal, results in smaller families.

Concubinage, which one might expect to enhance the birth rate, is said on the contrary, to depress it, since



After Raymond Pearl

▲ THE FERTILITY OF NEGRO AND WHITE WOMEN appears to be similar. The chart shows mean pregnancy per 100 ovulations in women who married only once, had no gynecological disease, and did not use contraceptives

a large number of women are removed from the full exercise of their reproductive possibilities. Women under this system are individually unlikely to have as many children as they would if married to one man, in spite of the impressive totals of offspring that a sole male under such a system may pile up. Similarly large scale prostitution has the same consequences but for a different reason or reasons, one of which is the prevalence of social diseases among the practitioners of this profession. But social disease apart from its existence among prostitutes is also a very significant factor in reducing the birth rate in the general population. This alone was responsible in large measure for the rapid depopulation suffered by Polynesia in the nineteenth century. Let me cite a single instance. The Marquesans at the time of Cook's visit toward the end of the eighteenth century, possessed a population estimated at around 100,000. In 1920 there were about 1600 natives left—less than 1/50th. A survey I made there ten years ago, disclosed a large number of sterile marriages and a high prevalence of miscarriages. Gonorrhea and syphilis were rife. The prospects looked very bleak indeed that this handful of once magnificent Polynesians could long survive. About 15 years ago, however, one of the government physicians began to combat social diseases in a few localities, and in a relatively short time the birth records began to show a remarkable increase. For the first time in over a century a favorable balance was established precisely in the localities where modern medical treatment had been administered.

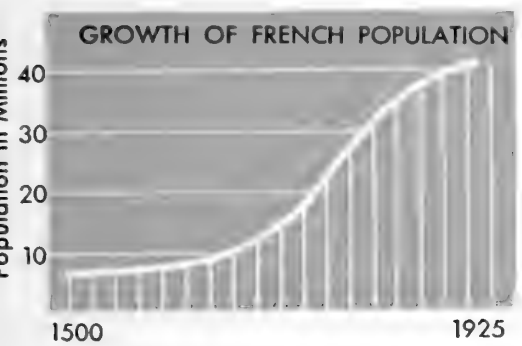
It has frequently been suggested that urbanization, with its attendant nervous tensions, may be one of the causes of sterility and reduced reproductive capacity. If it is, we cannot assess its role in the complex of factors which are operating toward this result. One of New York's most distinguished gynecologists once told me that he was able in a fair proportion of sterility cases to achieve cures by prescribing rest and travel.

Perhaps the most effective curb on the birth rate is the various techniques of contraception. The idea of contraception is a very old one. It was known in antiquity. But only in recent times has its practice become almost universal in some countries and in certain classes in most civilized societies. Probably no other single factor has been so effective in cutting down the birth rate. Certainly the present drop in birth rate coincides with the adoption of contraception, and this rate is lowest where contraception is most widely used and highest where it is unknown.

In the long run, the catastrophic checks on birth rate are less potent than those already mentioned. Their immediate influence may be more drastic, but, unless a population is already in decay or sharply reduced in number, recovery from them is fairly rapid. Thus famine, which has swept over China and India repeatedly, carrying off millions to death and cutting back sharply the birth rate, seems to have affected but little the general reproductive rate. It has been calculated that between 108 B.C. and 1911 A.D. China was subjected to 1828 famines, or almost one a year. Britain between 10 A.D. and 1846 suffered 201 famines, or 1 every 9

years. India endured 34 between 1769 and 1878, or 1 every 3 years. While these disasters may temporarily reduce the birth rate, they seem to have no permanent or long enduring consequences on reproductive tendencies. In other words the recuperative ability of a population soon makes up losses suffered from such causes when the short-lived cause itself is removed. Long continued war may also exercise a depressing effect on the birth rate. There has frequently been observed a sharp but temporary rise in birth rate at the initial stages of warfare, but this spurt declines into a lag as war continues, and its consequences extend into the post-war period. In the present conflict, the magnitude of the dislocations are beyond our experience, and it would be hazardous to base predictions on the past. After the last war, however, birth rates adjusted themselves fairly rapidly to the pre-war positions and continued their evolution from that point.

The other component in the equation of natural increase is the death



THE TYPICAL S-SHAPED CURVE of population growth, here represented by France, shows a slow beginning followed by a rapid rise and finally a gradual leveling off. The curve for the United States, rising from just under four million in 1790 to 132 million in 1940, would show a rising slope that has scarcely begun to flatten out

rate. In pre-industrial societies and among most primitive groups, this perhaps more than the birth rate is responsible for the dynamic status of a population. There are exceptions, to be sure, but in general a population not appreciably affected by artificial checks on the birth rate will increase as its death rate drops, and will become static when the death rate approaches the birth rate. In the past, the rise of the death rate through epidemics, famines, war, or disease has been more effective in reducing the rise of a population than fluctuations in the birth rate. Conversely, the amelioration of living conditions, improvement in public health, and advances in medical care permit a rapid increase in population by reducing the death rates. The phenomenal expansion of the population of Europe and, indeed, of the world during the nineteenth century may in large part be attributed to these factors. Only as the birth rate begins to follow suit and to overtake the decline in death rate is a static or declining population once more established. This has already happened in France. It seems about to happen in England and the United States.

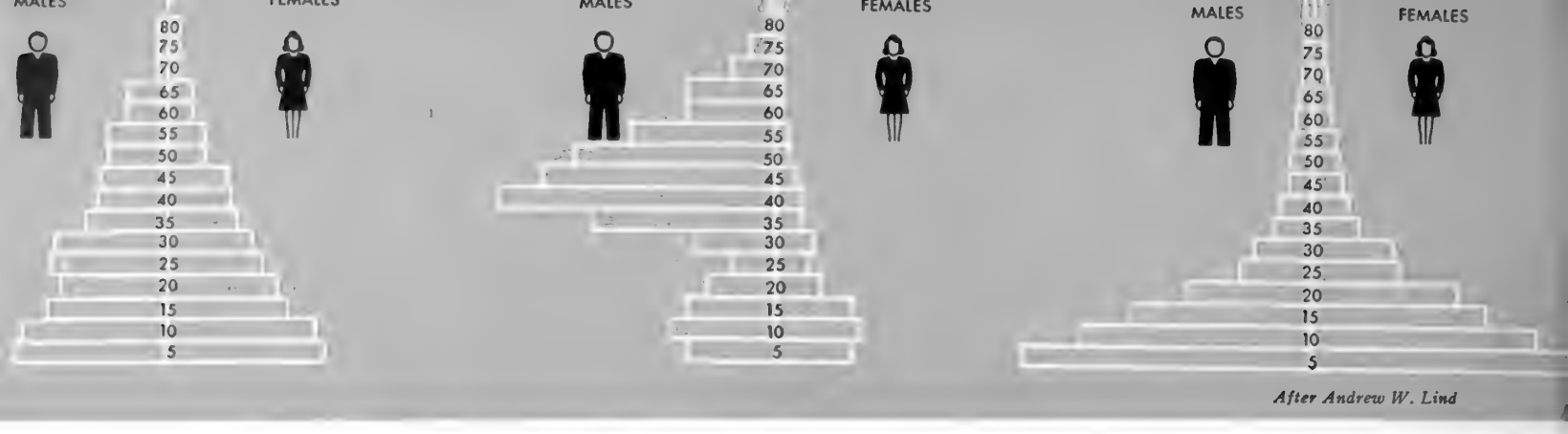
The extraordinary growth which the populations of the world have undergone in the past century or more has stimulated a good deal of speculation on the nature of the phenomenon. Raymond Pearl has reduced it to an equation and has generalized it to the form of a sigmoid or S-shaped curve. Such curves begin by rising slowly, reach their steepest slope at the middle of their spans and then decelerate gradually. Their application to populations is based on the thesis that a population becomes static when it has reached the limit of the current means of subsistence. When these sources of subsistence are increased, growth takes place. But the new spurt is proportional to (a) the absolute amount of growth already achieved and (b) the amount of unutilized or unexhausted means of subsistence. Such curves fit quite well the history of modern populations and have served many students in their predictions on the future size of existing aggregates.

But to describe the phenomenon does not explain it. Corrado Gini has a somewhat anthropomorphic explanation. He considers a population to be something like an organism—that it has a youth, a middle, and an old age. During its vigorous youth it grows rapidly. Then as increasing age makes itself felt, it begins to lose its reproductive force and becomes static or even declines. It would be difficult on this basis to explain the vigor in the ancient loins of China and Italy.

Warren S. Thompson, on the other hand, stresses the importance of environment, by which, I take it, he means agricultural and technological improvements. Looking at the full sweep of man's history, we do see definite increases in the density of population when new procedures or inventions permit the support of larger numbers. Hunting or food-gathering societies are not usually able to maintain a population as large as an agricultural community in the same area. In aboriginal America, the largest concentrations existed precisely where settled agriculture was well organized. Cities and large populations in the Old World first appeared in the rich valleys of the Nile, the Tigris, the Euphrates, and the Indus, where agriculture received its initial development. The remarkable expansion of population that is so striking in recent centuries coincides with the advent of industrialism, the expansion of trade, and the exploitation of the New World. These events have enriched the sources of subsistence and permitted a new growth of population.

To list the total number in a population or even to define its rate of growth does not tell the whole story. A population not only has size; it also has structure. By this I mean that populations are composed of different kinds and categories of people, the numbers and relationships of which vary from time to time and from place to place. If we classify a given population according to sex and age, we can plot the percentage of the population in every category. Normally, the result is a pyramid with the most numerous class where one naturally expects it, in the youngest age at the bottom, and the least numerous among the most aged at the top. Such a pyramid tells us much about the past, present, and future of the population it represents. If the pyramid has a relatively broad base, we may anticipate, other things being equal, a rapidly growing population, since the future reproducers of the populations are to be found in the youngest generations. On the contrary a population barely replacing itself will have a relatively narrow base.

The profiles of the populations of the United States and various western European countries reveal a striking change during the past century. As the death rate has declined, the number in the older age classes has increased. At the same time the base has contracted due to the reduction in birth rate. We see, therefore, a change in the age structure of these populations that has had a profound significance not only on the growth



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An aging population, or to be more exact a population with an increasing proportion of middle-aged and senile individuals, may influence the social, political, economic, and intellectual orientation of a nation not only directly through its voice in the government but also indirectly by more subtle means. Even though we may not have at hand objective evidence on this possibility, it is a legitimate field of inquiry. One cannot help but wonder whether a young Elizabethan England would have approved of the cautious, elderly appeasers of Chamberlain's England. I do not, of course, wish to imply that the difference between these two eras was simply a matter of the age of their respective leaders. I am aware, moreover, of the complicated background of the pre-war situation. And I know that Mr. Churchill celebrated his 70th birthday just the other day. But is it altogether unreasonable to expect the policies of nations to reflect the age of the policy makers and of the electorate?

Age and sex, however, are not the only components of population. Indeed, the only limit to the breakdowns and the classifications to which a national aggregate may be subjected lies in the records available. Most of them, however, are temporary and ephemeral characteristics of little or no biological importance. Even much of the census information serves no biological ends. It may be valuable, for example, to know the extent of illiteracy by states and other things about the educational status of the populace. Economists may find statistics on home ownership extremely useful. But these data have no bearing on biological structure. Even the age and sex classifications fail to tell us much of the biological quality of the people. Yet it is of paramount interest to know what hereditary differences in quality exist and whether the superior or inferior individuals are increasing more rapidly.

For example, the composition of a population divisible into 3 distinct groups, would undergo changes proportional to the rates of growth of each group. The accompanying diagram indicates the magnitude of change in a hypothetical case within the bounds of probability.

Such changes in the relative strength of diverse components in a population are much more common than we have come to realize, because our data are rarely presented in this form. Yet we may see in the course of the nineteenth century the Scotch drop from 15% to 10% of the combined population of England, Wales, and Scotland. In the United States, immigration and differentials in birth rates changed the population from a predominantly English one to one in which German, Irish, Italian, Polish, and other continental nationalities represent considerable percentages, with a relative if not an absolute loss in the English contingents. It is interesting that this tendency, in force for a century, and one that alarmed certain writers, seems now likely to be reversed to some extent. At present the agricultural south, largely British in origin, is furnishing a disproportionate share of the national increase. The high birth rates of the newer immigrants, formerly viewed with foreboding, have dropped below those of the mountain whites of the South. I cite these figures not because I consider the groups significantly different but to illustrate the possibility of a rapid shift under the influence of persistent trends.

If therefore, a total population may radically change its group composition, is it not possible that its biological quality may also undergo alterations? If the Kallikaks and the Jukes, overburdened with degeneracy, outbreed the Edwardses, may not the qualitative character of the total population suffer? To deny the possibility would be purblind, to affirm the

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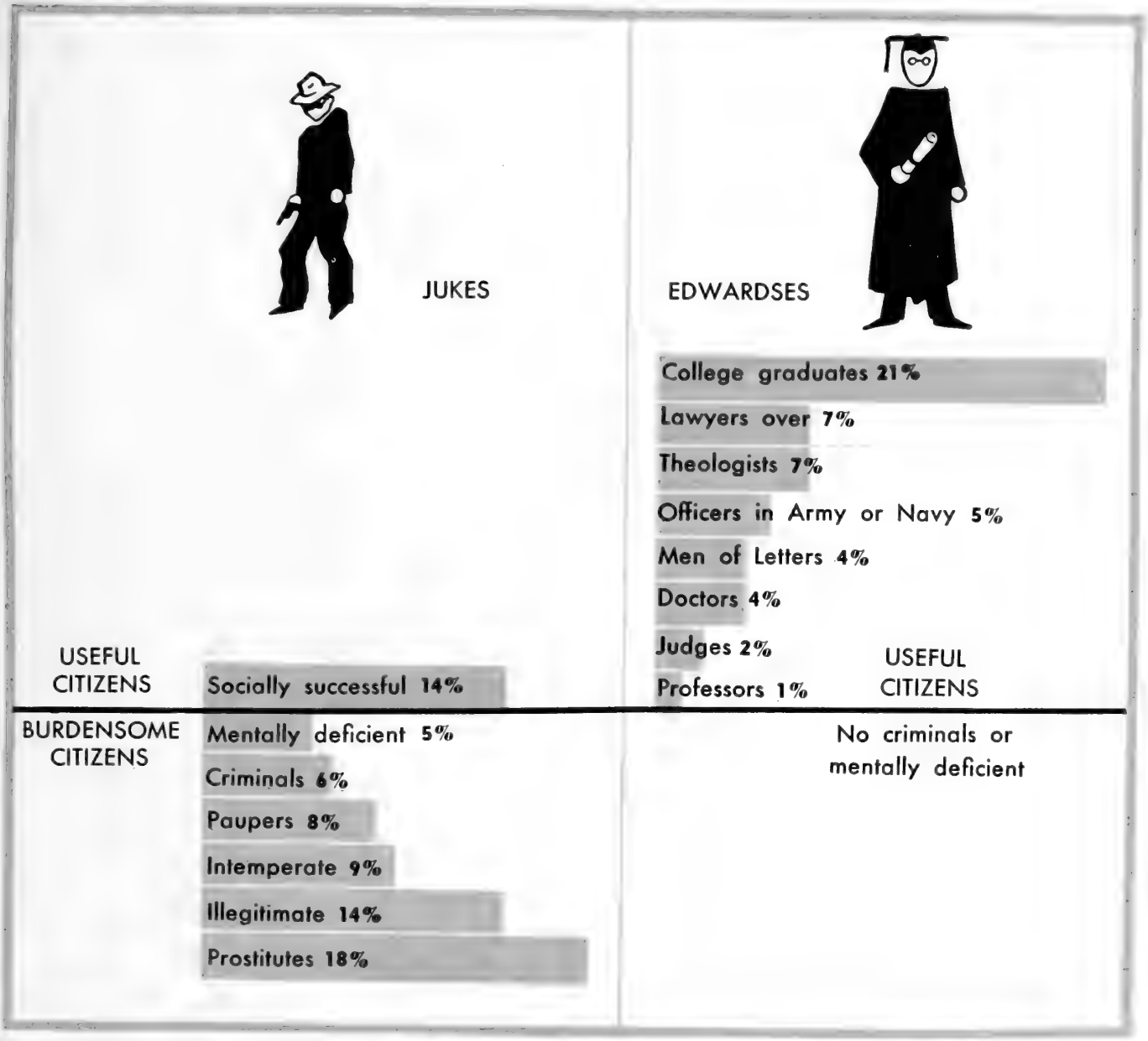

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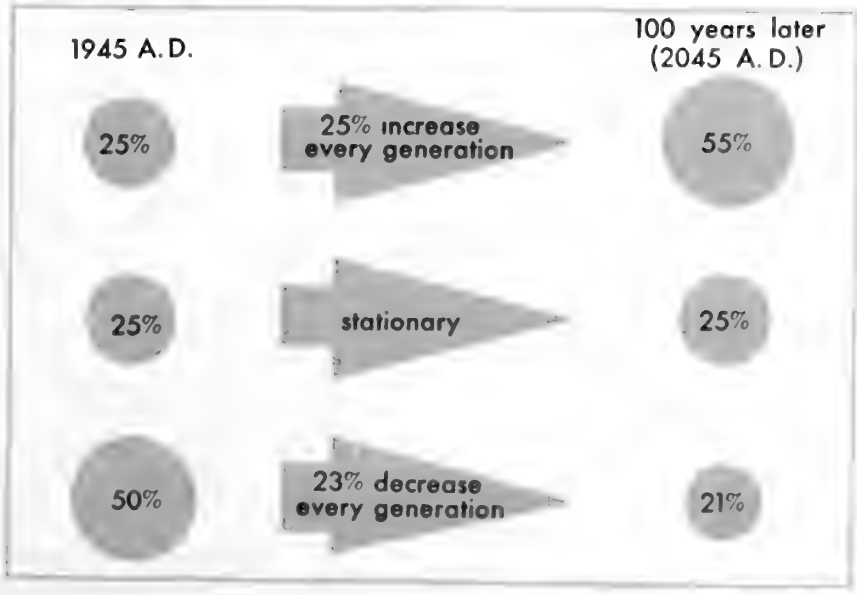
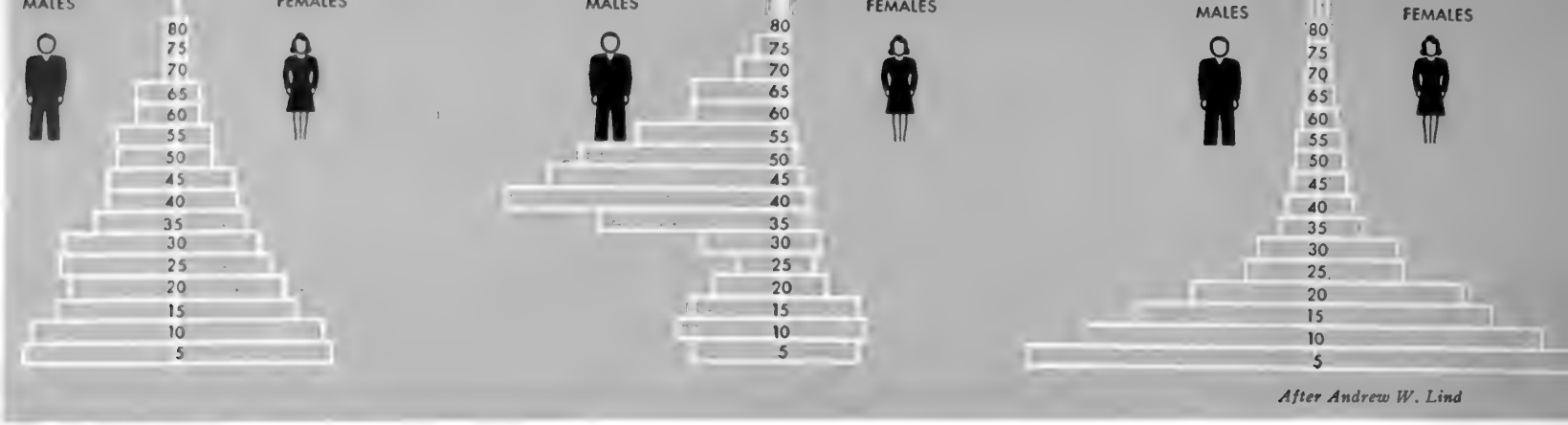
➤ A POPULATION can change its composition profoundly in a few generations if the various components increase at different rates





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JUKES

EDWARDSES

	JUKES	EDWARDSES
USEFUL CITIZENS	Socially successful 14%	College graduates 21% Lawyers over 7% Theologists 7% Officers in Army or Navy 5% Men of Letters 4% Doctors 4% Judges 2% Professors 1%
BURDENSOME CITIZENS	Mentally deficient 5% Criminals 6% Paupers 8% Intemperate 9% Illegitimate 14% Prostitutes 18%	No criminals or mentally deficient

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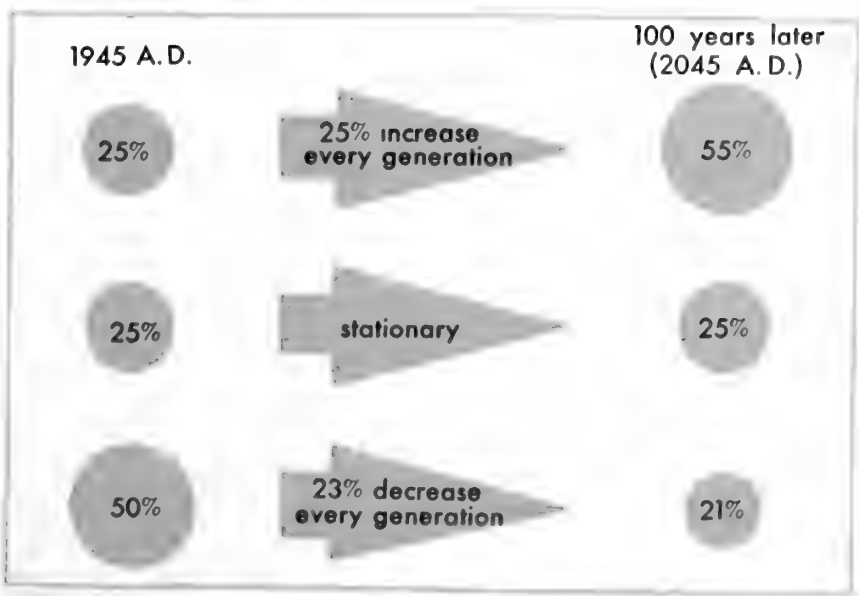

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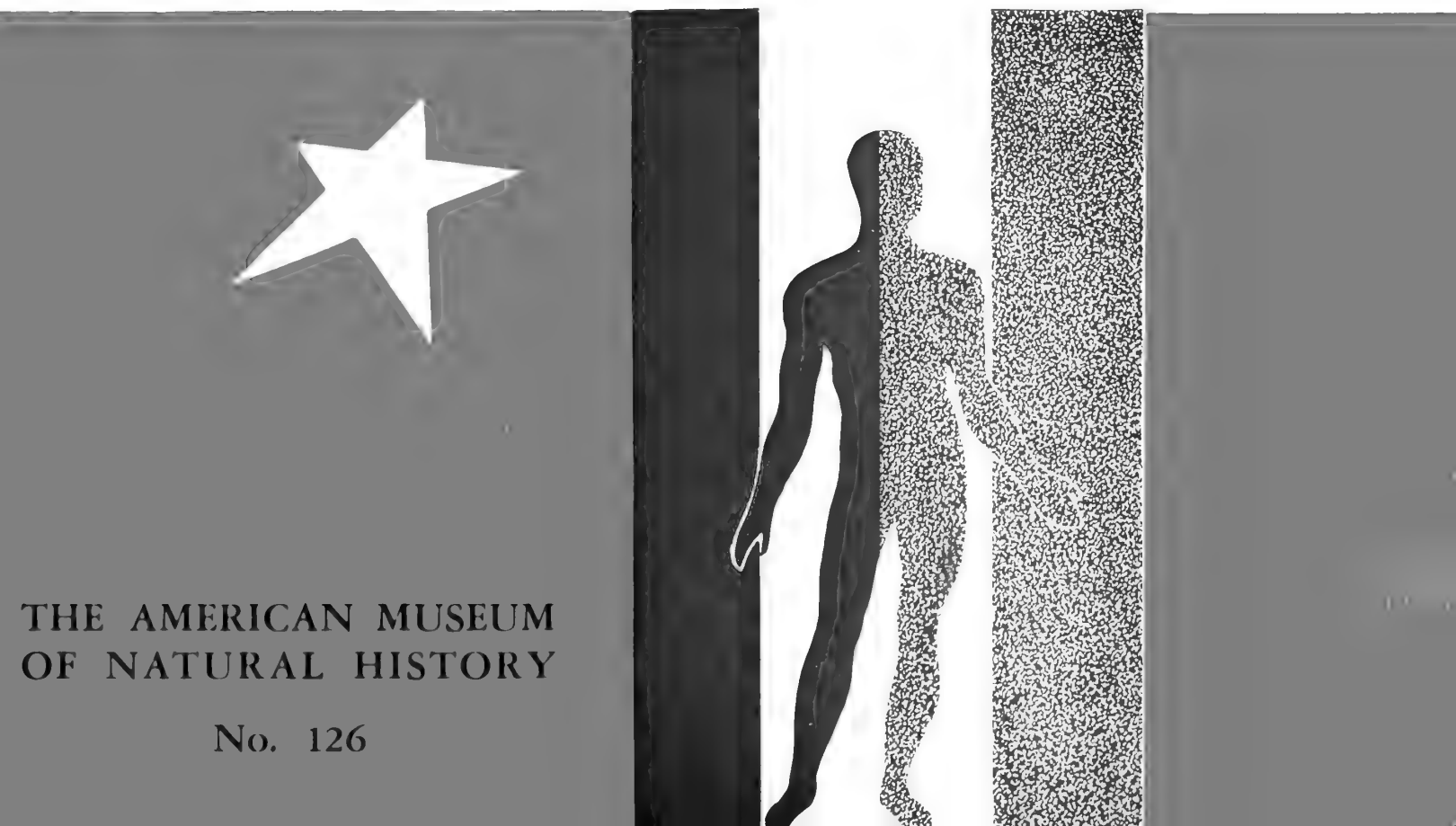
AMERICANS

Yesterday, Today, Tomorrow

By Harry L. Shapiro



THE AMERICAN MUSEUM
OF NATURAL HISTORY

No. 126

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Yesterday, Today, Tomorrow

By

HARRY L. SHAPIRO

MAN AND NATURE PUBLICATIONS

Science Guide No. 126

THE AMERICAN MUSEUM OF NATURAL HISTORY

Central Park West at 79th Street, New York 24, N. Y.

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NORMA—the average American girl

SHE IS MODELED from recent measurements of 15,000 women from many parts of the United States and from various walks of life, including series of college students and other thousands of native white Americans. She is slightly heavier yet more "athletic" than her grandmother of 1890 and has lost the shrunken waist induced by tight corsets. As to the beauty of her figure, tastes will vary; fashions change ideals from one generation to the next. Norma is not meant to show what ought to be; she shows what is.

Dr. Robert Latou Dickinson, who drafted the proportions and posture of the figure, has devoted six years with Abram Belskie to the planning and finishing of anatomical, obstetric, and surgical models which might be widely distributed for teaching purposes. In this work, at the New York Academy of Medicine, he has consulted the great anthropologists in person and tapped all the statistics to ensure accuracy in all details. He shows in Norma the average American girl of our day, 18 years of age.

The sculpture has been done by Abram Belskie, member of the National Sculpture Society.

The statue, like that of Norma's "brother" on page 252, is reproduced for the first time in NATURAL HISTORY Magazine through the courtesy of the sculptors and the Cleveland Health Museum, which will take over production of the series.

A.M.N.H. Photo

America

Scientific studies reveal that we have changed considerably since the days of our forefathers. The typical American is certainly quite different from what other nations have predicted for us, also perhaps different from what we ourselves have imagined

Most Americans, in conversation with representatives of other nationalities, have probably found themselves discussing what it is that distinguishes the people of the United States and as frequently, no doubt, attempting to define the character of the other nationalities in such a mixed company. In this world of self-conscious nationalism, almost every country has acquired a personality and a type—often enough, a kind of Janus or split personality, one face as the country sees itself and the other as seen by its neighbors.

The British, collectively, in their national self-portraiture, are inclined to emphasize quite naturally the traits they regard as lovable, worthy, gentlemanly, or noble. Their native spokesmen describe them as reserved, sensitive, poetic, devoted to fair-play, fond of sport, inclined to "muddle through," and eminently law-abiding. Foreign and less generous observers are more likely to dwell on their pig-headedness, their snobbishness, their perfidy, and various other less agreeable human traits.

The French, too, take pride in their catalogue of national virtues, which they sometimes imply are uniquely theirs, such as their logic, their intelligence, their thrift, their capacity for passion; while in the hands of their critics, their thrift becomes parsimony and their passion a form of immorality and lack of restraint.

We Americans, also, have a fa-

s—Yesterday, Today, Tomorrow

vorite chromo of ourselves that we like to hang in the family parlor. We picture ourselves as idealistic, honest to the point of being easy marks for our devious neighbors, generous, hospitable, friendly, inventive, efficient, competitive, and progressive. Many Europeans look darkly at this picture and take on their own account a few candid camera shots that are as flattering as passport photographs, revealing us as dollar-chasing Shylocks; insensitive to culture, meddlesome, flippant, boastful, and preaching; gangsters who are ridden by a mania for speed, gadgets, and law-breaking.

Although these characterizations are stereotypes, which at their best are merely acute generalizations and at their worst malicious and inaccurate, they are symptomatic of the trends of national differentiation that arise from differences in history, environment, and culture. Even if we cannot measure it objectively, the reality of national patterns of character structure is patent enough from experience.

An American, even of the purest English descent, who reverses the trail of his ancestors and hopefully transplants himself in England, is likely to encounter some difficulties in recrossing the line that now divides an Englishman from an American. The experience of some of our most celebrated expatriates illustrates how American Americans have become. Henry James, for all his love of the English and their ways and for all his efforts, never succeeded in passing as an Englishman among Englishmen, although it must be admitted that he sometimes fooled Americans. Sargent and Whistler, utterly different as they were in so many things, always remained Americans as far as the English were concerned, except when they were claimed as ornaments of British painting. Sir Osbert Sitwell recalls that

One American Ideal

ONE IDEAL in the feminine figure is represented by Rosemary Sankey, chosen to epitomize the "high fashion girls" of John Robert Powers. These models, constituting a very uniform physical type, are significant because they are eagerly sought after as dress models and are obviously much admired by the public. In this group, bust, waist, and hip measurements of 34-24-34 are considered close to the ideal. The greatly increased height, the notably wide shoulders and the slender hips of the "high fashion girl" combine to differentiate her from Norma; but these same characteristics may also be regarded as the extreme of a tendency that has been noted to a lesser degree in the average American girl in recent generations.

Miss Sankey herself shows a figure that is further in this direction even than the average "high fashion girl." Her measurements are: shoulder width, 14.9 inches; bust, 33⅛ inches; waist, 23 inches; and hip width 11¼ inches. She is 5 feet 7 inches tall and weighs 117 pounds.

Photograph by Don Selchow.

when his father commissioned Sargent to paint a conversation piece of the Sitwell family, Lady Londesborough, the maternal grandmother, distinctly disapproved of the choice of Sargent on the grounds that he was an American. I should perhaps add that Sitwell, père, did his best to find an English painter and only settled on Sargent after discarding several English candidates as inadequate.

Personalities, however, although they seem to persist like the smile of the Cheshire cat long after the body has vanished into thin air, do enjoy ordinarily a physical embodiment. Certainly no picture of the American people as a whole can omit this vital component, which, unlike its abstract personality, is much more susceptible to exact description and objective measurement. The existence of a physical type, distinctively American, has for a long time been quite generally accepted both by Americans themselves as well as by foreigners. Indeed, regardless of any scientific support for such an opinion, one would have to be singularly impervious to suggestion to escape sharing it. Hollywood presents us with an inexhaustible parade of "typical American" beauties. Charles Dana Gibson delighted our mothers and our fathers with the apotheosis of the American girl of the 1900's. Lord & Taylor advertises "that American look" as the product of our native soil. And who is not familiar with the lineaments and aspect of Uncle Sam, our national portrait. If our artists, our impresarios, and our copy-writers had failed to convince us, our own observation could not. Americans, visiting Europe before the war, were easy to spot, not only by fellow Americans but also by natives and by those whose business flourished by virtue of their skill in this species of detection. No doubt clothes, manners, and speech contributed to make it relatively easy to distinguish an American from the indigenous population; but frequently enough, recognition was possible even without these adventitious aids.

I have been unable to determine precisely when Americans, or Europeans for that matter, first became aware that there was something that could be called an American physical type. Discussion of a generalized American character, it is true, appears well established by the middle of the eighteenth century. Franklin, for example, speculative as he was on many topics of general interest, held views on this, too. And even earlier one can find such colonial worthies as Colonel Byrd and the Mathers speaking of local manners and behavior as if they already recognized an American pattern, although not designating it in such broad terms. Certainly, by the end of the eighteenth century, interest in the American character, stimulated by the Revolution and the birth of a new nation, occupied the attention of almost every writer who ventured to discuss and describe the United States.

English visitors were particularly aware of our national personality; with few exceptions they found it unattractive and, of course, inferior to their own. Isaac Weld, Mrs. Trollope, Charles Dickens, and Captain Hall, among a host of other English travelers in the nineteenth century, standardized the excrescences of the portrait. In fact, one is somewhat amazed in reading this literature to reflect how analogous it is with the recent writing on Russia. The United States at the end of the eighteenth century and the early nineteenth represented to the Europe of that day a reprehensible and dangerously radical departure from political decorum. European and particularly English observers loved to dwell on the less attractive side of life in America. Democracy was not what it was cracked up to be. The democrats chewed tobacco; they entered into conversation without waiting the formality of an introduction. As servants they were forward and insisted on regarding themselves as good as their masters. Their offspring were independent and pushing. Democracy was noisy, aggressive, and lacked the refinements of traditional societies. Table manners were appalling and public conduct beyond words. Public and private conveniences, roads, carriages, trains, hotels—all were inferior to their European counterparts and uncomfortable.

Life, manners, and character altogether were so unsatisfactory that they seemed to take up all the attention, and little or nothing was left over for observation of the physical traits of Americans. When comments were made, they were apt to be disparaging. American girls had poorer color than the rosy-cheeked English girl. Americans had poor teeth, or the women were pretty enough as girls but faded quickly. But the American as an emerging subtype, neither English nor Dutch nor French but American, was slow in being recognized, or at least less obtrusive to foreign visitors than the facets of our national behavior. Crèvecoeur, however, a sympathetic French observer of American life in the latter half of the eighteenth century, commented enthusiastically on most aspects of it and with reference to Americans as a people wrote "here individuals of all nations are melted into a new race of men, whose labors and posterity will one day cause great changes in the world." This is one of the earliest references I have been able to find to the famous assimilation process that was to become widely known as the "melting pot."

Americans themselves, no less than Europeans, commented little, if at all, on the existence of an emergent physical divergence from their European forebears until the latter part of the eighteenth century when political events were beginning to weld a sense of nationality among the scattered colonies along the seaboard and to stimulate a feeling among Americans that they were a distinct people. Since exact evidence is lacking and contemporary observations are scanty, we cannot, in fact, be positive that there was in colonial times any obvious deviation among the colonials from the physical standards of their ancestors. Perhaps one of the reasons for this inattention sprang from the circumstance that for well over a century after the first settlements, the colonists were accustomed to think of themselves not as Americans but as Englishmen, Hollanders, Germans, or Frenchmen. They had come to the New World as Europeans, bringing with them not only the biological heritage but also the manners, customs, and ideas of their native lands. So conscious were they of their Old World origins and ties that even after a century of residence in the New World, they continued to call themselves Englishmen, Frenchmen, Swedes, or Hollanders. Their settlements were named New England, New Amsterdam, New Sweden, Nova Scotia, or, in loyalty to their sovereigns, Virginia, Carolina, Maryland, and Georgia. They fashioned their houses after models familiar in the countryside from which they came. They reproduced, as far as the

new environment permitted, the life they knew in the old country; with such success in the Pennsylvania Dutch country that an eighteenth century traveler was amazed at the fidelity of the reproduction. Even after generation had succeeded generation, a native Virginian or New Englander of colonial times might still speak of "going home" when he merely meant a visit to England.

One of the earliest commentaries on the physical characteristics of Americans seems to have occurred in the latter part of the eighteenth century. The principals were our own Thomas Jefferson and the Abbé Raynal, a French popularizer and encyclopedist. Raynal, adapting Buffon's ideas on American fauna, had applied them specifically to the Europeans transplanted to the New World. The thesis was briefly this. Buffon, the grand panjandrum of French scientific circles, had come to the conclusion that American animals were smaller and inferior to their European equivalents. In addition, he cited reports widely current in Europe that domestic animals brought to America rapidly degenerated. It was firmly believed that not only did cows, horses, pigs, and other barnyard denizens become smaller and runtier, but they fell off in production. Cows in America, it was said, produced milk in quarts where in Europe they yielded in gallons. Speaking of the indigenous tribes of America, Buffon wrote:

"The American Savage, it is true, is little less in stature than other men, yet that is not sufficient to form an exception to the general remark—that all animated nature is comparatively diminutive in the new continent. In the savage, the organs of generation are small and feeble; he has no hair, no beard, no ardour for the female; though more nimble than the European, from being habituated to running, he is not so strong; possessed of less sensibility, yet he is more timid and dastardly; he has no vivacity, no activity of soul, and that of the body is less a voluntary exercise than a necessary action occasioned by want. Satisfy his hunger and thirst, and you annihilate the active principle of all his motions; and he will remain for days together in a state of stupid inaction."

To account for this degeneracy, Buffon spoke like a true eighteenth century naturalist and attributed it to the American environment and in particular to the fact that America, having only recently emerged from the sea, possessed a "watery climate" which was less favorable as compared with the presumably drier and more invigorating climate of Europe.

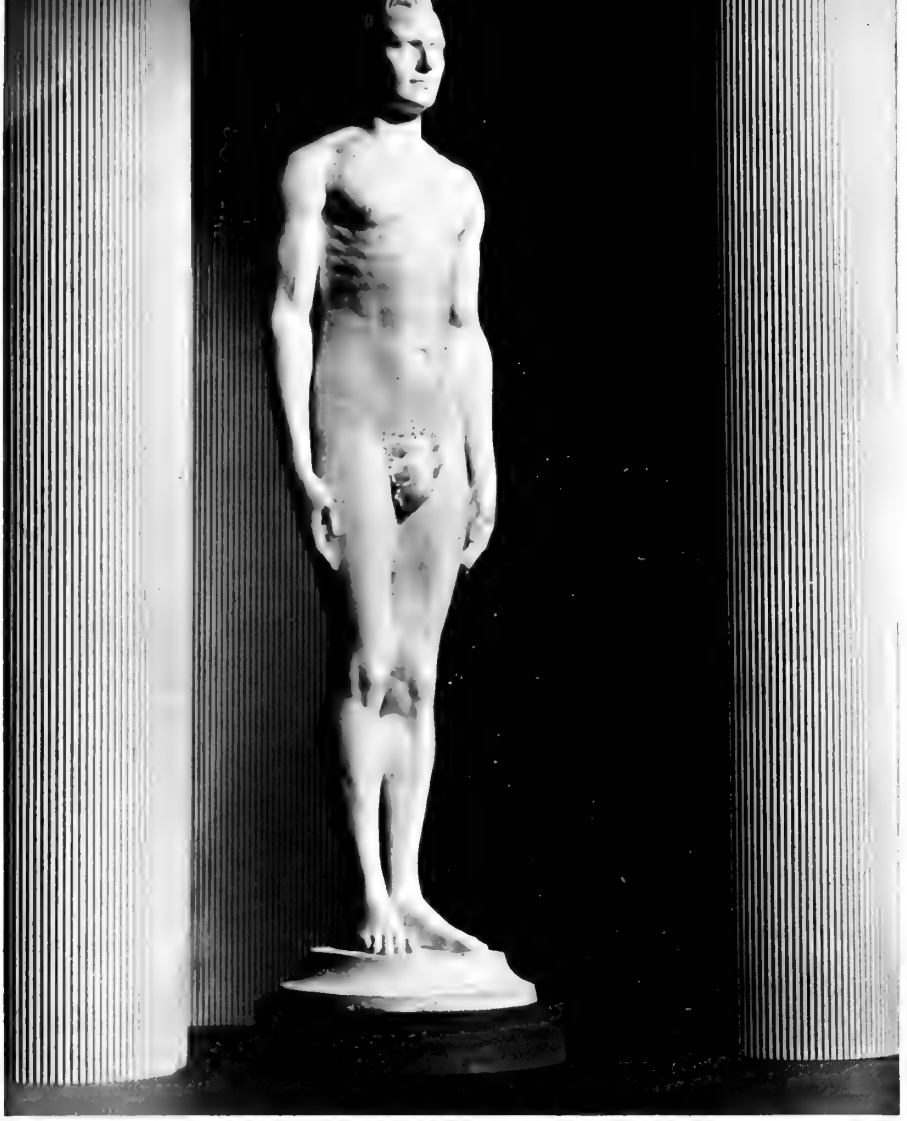
This then was the hypothesis that Raynal took up and expanded to include all the human fauna of America, aboriginal and transplanted. At this point, Thomas Jefferson took up the cudgels and belabored Raynal and Buffon with tables of comparative weights that left no shred of comfort to his opponents. In instance after instance Jefferson demonstrated that the American species were distinctly heavier and that, if weight alone were any criterion of quality, there could be no doubt that the superior article was to be found over here. Whether our climate were watery or not, Buffon and Raynal were certainly all wet.

Although this footnote in our history is amusing in view of what has actually happened to the physical development of our population, it throws no light on eighteenth century opinion on the progressive development of a native type except in so far as it was alleged to be a degenerating one. Local differentiation to some extent was recognized, to be sure, and the Yankee as contrasted with the Southerner was becoming a stock figure; but the distinctions were based largely on manners, attitudes, and way of life, although physical differences seem not to have been completely ignored. In this period, too, the frontiersman began to crystallize as a physical type, although the characteristics that marked him are not always consistent or explicit. It is, however, only after the Revolution that one becomes aware of a growing tendency of Americans to think of themselves as a nation—as Americans, despite the tendency of the Virginian or the New Englander to cling to a local allegiance. This increasing sense of a common nationality found expression in the opening years of the nineteenth century in the discovery of a representative type in Uncle Sam, who rapidly gained a national personification that has continued to the present day.

How much truth there was in Uncle Sam is a matter of conjecture. Tall, lean, long-legged figures seem to have become frequent enough among Americans of this period to have attracted comment as symptomatic of a national trend, but it is unlikely that Uncle Sam approximated anything like an average of the total population at the time of his creation. Perhaps, like a caricature, he owes his being to a deliberate exaggeration of an actual but subtle tendency in the population. He was, in other words a type of some frequency in the general population but not an average, and his selection to represent the nation rested on the fact that as a type he was to be found more characteristically here than in other countries.

Since Uncle Sam was not the *average* American of 1800 (at least we have no evidence that he was), it would be profitless to compare him with the American of today in an effort to determine whether or not the American people have altered appreciably in the course of 150 years. We have, fortunately, for our contemporary population the kind of data that was completely absent in 1800. Although the material now available falls short of perfection, it is extensive enough to give us an excellent idea of the average dimensions and proportions of the American man and woman of our own times,—the kind of summation impossible for earlier periods in our national evolution. The principal sources from which the reconstruction of the average American male and female may be drawn are varied. They include the information made available by a survey of a couple of million men in the army during the first World War, special studies of the old American stock, series of college men and women from various parts of the country, a sample measured at the recent World's Fair in Chicago, insurance company records, and extensive data obtained by the Bureau of Home Economics on 15,000 American women who were measured in detail to provide more accurate dimensions and proportions for sizing women's ready-made garments.

Recently, a distinguished team of co-workers, Dr. Robert L. Dickinson and the well-known sculptor, Mr. Abram Belskie, who have collaborated in the past to produce a unique series of anatomical models, turned their talents to creating models of the average American male and female in the full flush of early maturity. Their results, embodied in the two handsome figures sculptured at one-half life size, which are reproduced on accompany-



A.M.N.H. photo

▲ NORMA'S TWENTY-YEAR-OLD "BROTHER" is also a product of Dr. Dickinson's studies and was modeled by Abram Belskie. Both of these statues and the measurements on which our knowledge of physical trends is based, leave little doubt that the figure is improving esthetically

ing pages, translate into three dimensions a composite of the available data. The female figure, named "Norma" appropriately enough, represents the norm or average American woman of 18 to 20 years of age. "Normman," her male counterpart, is modeled on averages for 20-year-old males.

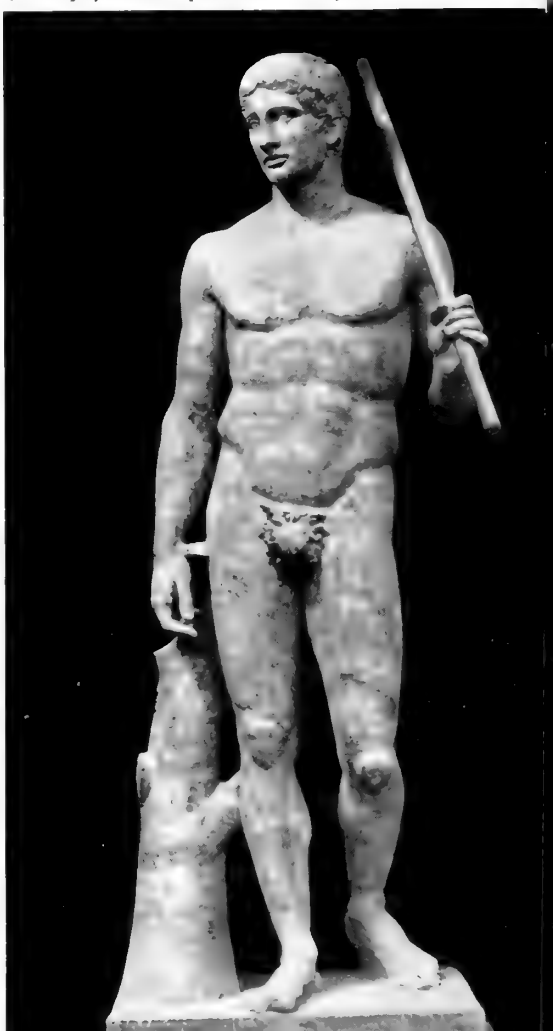
The effect these figures convey is one of a body that is tall, long-legged, and well proportioned, and far more favorably impressive, at least esthetically, than might have been anticipated from casual observation. In fact, Norma and Normman, although they were designed to conform with the average adult before the onset of the ravages of age, exhibit a harmony of proportion that seems far indeed from the usual or the average. One might well look at a multitude of young men and women before finding an approximation to these normal standards. We have to do here then with apparent paradoxes. Let us state it this way: the average American figure approaches a kind of perfection of bodily form and proportion; the average is excessively rare.

Ordinarily, when we think of perfection, or the approach to it, we place it at one extreme of a curve of frequency, whose middle range or average is equivalent to mediocrity. Virtuosity, for example, is never at the middle of a curve of frequency. The most skilled musicians, the finest painters, the loftiest intelligences are rare and exceptional, never average for any population. Why, then, should the average bodily proportions strike us as a form of perfection; and if it is average, why is it rare? There are, of course, esthetic and anatomical considerations involved here, but I shall confine myself to a statistical explanation. The extremes of any single physical character are generally statistically rare, whereas the average is frequent. The middle ranges of stature are most commonly seen, the average weights most often recorded, the mean of a bodily proportion is the most usual.

All these averages are in themselves individually pleasing, and they are common and usual, observed singly. A very fat lady and a very thin one are both rated ordinarily as less attractive than one of more average weight. Obviously, then, if the averages of all traits are brought together in one individual, such a person is bound to agree with the standard not only for one but for all the characters that define bodily proportion. But the combination of so many averages in one person is rare and unusual. One may have an average stature but be far above normal in weight; another may conform to the average for height and weight but possess hips or shoulders that fail to achieve the mean. Thus it comes about that the

▼ DORYPHORUS, THE SPEAR THROWER: a Greek ideal of about 400 B.C. This figure, 7½ heads high, exhibits a massive torso and well proportioned limbs, combined to give an appearance of power rather than agility or speed

Courtesy of the Metropolitan Museum of Art



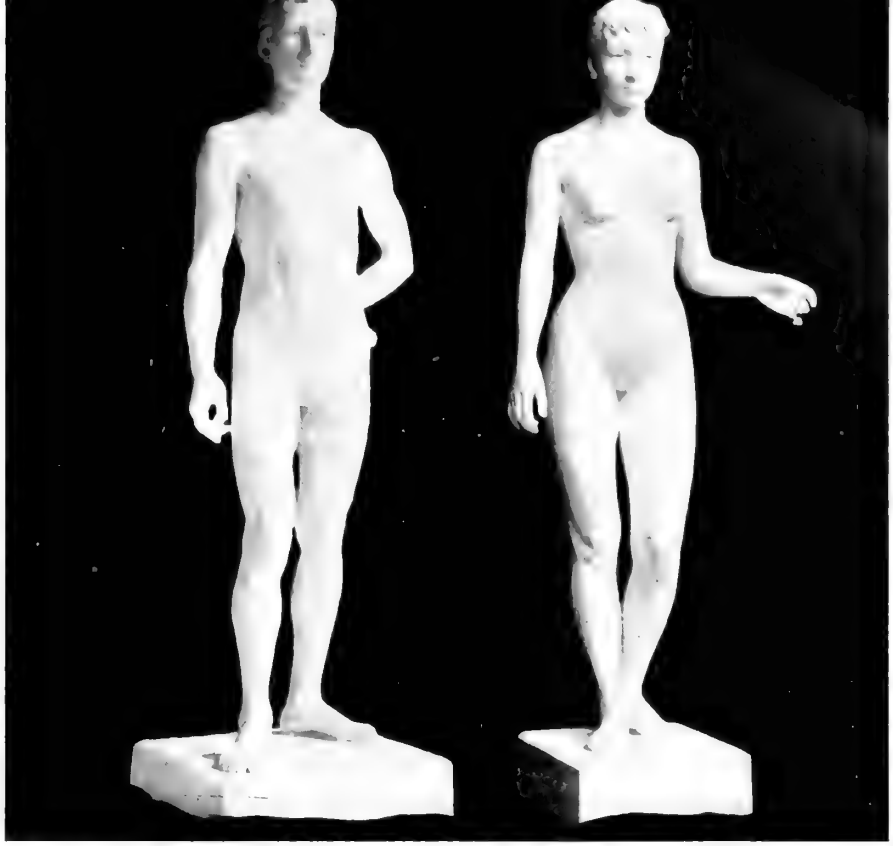
average physical type is pleasing but also unusual.

Bodily perfection like any other esthetic ideal is admittedly a matter of taste, a subject that may be dismissed with the phrase, "*de gustibus non est disputandum*," or carried into rarefied levels of sensibility. It is, however, interesting to compare Norma and Normman as created by Dr. Dickinson and Mr. Belskie out of the realities of living Americans with the ideal figures conceived by the classic masters according to artistic canons of bodily proportion. The archaic Greeks, bound by the traditions of Crete and Egypt, deliberately carved statues with exaggerated and often unlife-like proportions, and it is not until the fifth century B. C. that we find the classic figure fully developed. The sculptors of this period strove to create a harmonious and ideal body based on the proportions of living men and women but brought to a higher perfection of abstract beauty. It is an idealization rather than a copy of a living model. One of the most celebrated sculptures of this period is the Doryphorus by Polycletus (about 440 B.C.) which, because its proportions were regarded as approximating perfection, was known as the Canon. The height of Doryphorus is 7½ heads (measured from the base of the chin to the crown of the head). Compared with it, the average American male is much taller, (though still about 7½ heads high), and much more slender not only in the limbs but also in the torso. Somewhat later Greek sculptors like Lysippus (about 320 B.C.) lengthened their figures to 8 heads, but the solidity of body remains when contrasted with the modern American. The Venus de Milo, also 8 heads high, a proportion that agrees with that of Norma, is, however, much broader in development, with hips that look massive against Norma's relatively slender ones.

Since classic sculpture represented an ideal and not an average, we are warranted only in concluding that our averages of today are deficient judged by classic concepts of ideal beauty. Who can tell how far the contemporaries of Pericles were wanting by the same measures of perfection?

But modern notions of bodily harmony have changed. The world of fashion and photography, for example, favors an ideal and a canon distinctly its own. The "high fashion girl," whose elongated and elegant grace we see in the pages of the slick magazines and in the advertisements of high priced garments for women, is eagerly sought after as a dress model and much admired by the public. Her broad shoulders, slender hips, and long legs show off clothes to their best advantage and thus help sell the product she displays. Is she a type that suits the prevailing trend of a fashion that might tomorrow leave her demodé, or does fashion follow her contours because she represents an exaggerated but elegant form of a changing bodily conformation in American women?

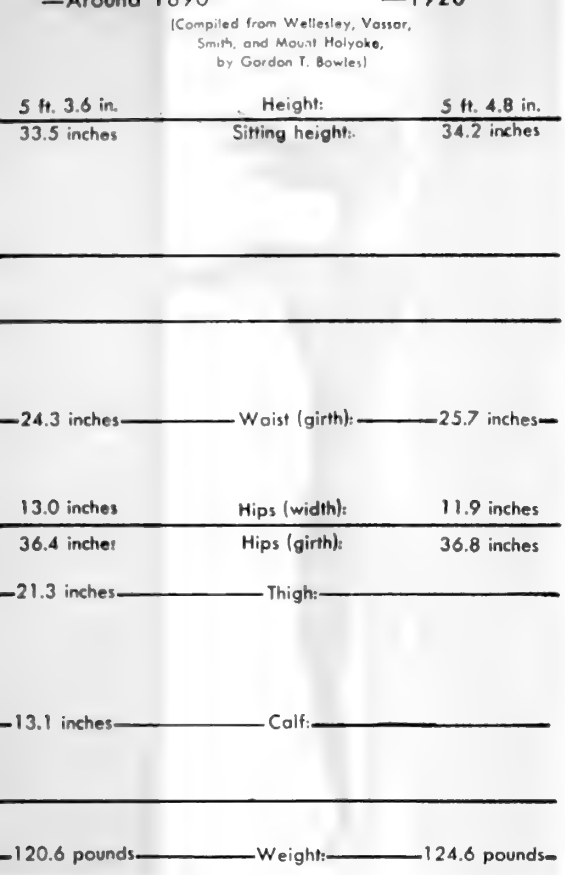
That the American woman, no less than the American man, has been changing in physique has been frequently asserted and is well known to clothing manufacturers, who have been obliged to make a number of alterations in their sizing formulae to fit the public. Our elders who have commented, sometimes unsympathetically, on the changes to be seen in the younger generations, may refresh their memories of their own intimate appearance of 50 years ago in the illustrations of Professor Dudley A. Sargent's figures of the average col-



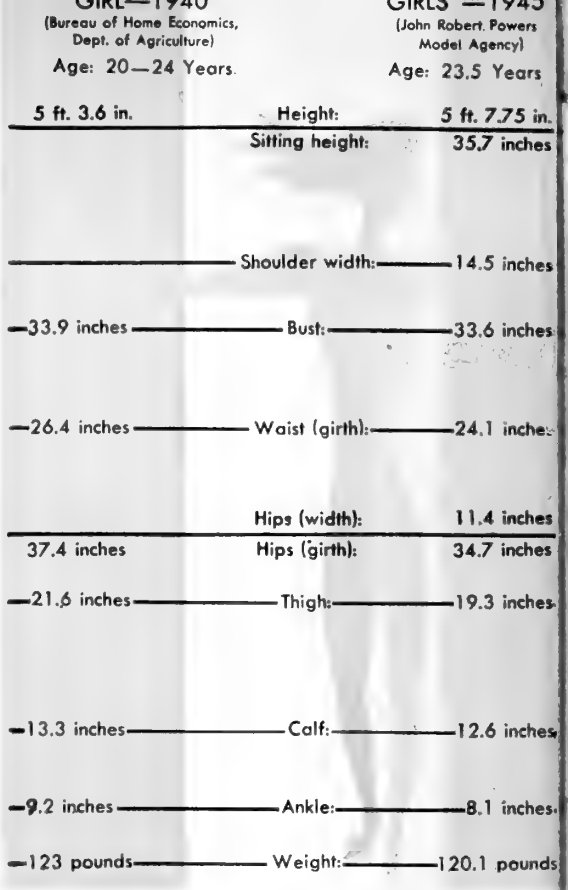
▲ THE AVERAGE young man and woman of the Gay Nineties as portrayed in two figures scientifically constructed by Professor Dudley A. Sargent. Both were shorter than their modern counterparts. The woman also had a narrower waist than her "granddaughter"

▼ THE EARLY GREEK IDEAL in feminine beauty is seen in the statue of Aphrodite of Cyrene, sculptured in the second century B.C. after a fourth century type

Courtesy of the Metropolitan Museum of Art



THE COLLEGE DAUGHTERS of 1920 were taller and heavier than their mothers but had relatively narrower hips



THE AVERAGE GIRL today is stockier than the College Girl of 1920, but her height is likewise increasing. Her bust measurement exceeds the "high fashion" girl's, but she is four inches shorter

lege man and woman of the gay 90's. These models were constructed from a large series of measurements of Harvard and Radcliffe students and make an illuminating comparison with the "Norma" and "Normman" of 1945. If the Sargent reconstructions are as representative for their day as the Dickinson-Belskie models are for the present generation, there can be no question of the esthetic improvement in the present population. The girl of the 1890's had a constricted waist, the effect no doubt of corsets and the hope of achieving a girth that could be spanned by a man's two hands, if such liberties were thinkable. She seems, moreover, somewhat disproportionate in having legs too heavy for her torso, or, if one prefers, a torso undeveloped for the size of her hips and legs.

We are fortunate in having at our disposal for such a comparison with the past an abundant body of exact evidence that leaves no room for doubt that a marked change has occurred in the physical development of our population. Repeated measurements on the students of various colleges throughout the United States all agree that this generation is considerably and consistently taller than its parents. One of the most extensive series in time covered is the Harvard study, which embraces a continuous record of around 75 years. Dr. Gordon Bowles, who has analyzed these figures with great skill, has been able to demonstrate a remarkable increase in size and an alteration in proportion in Harvard undergraduates as well as in college women in a number of Eastern schools. To indicate the rapidity and magnitude of the change, I shall cite the average statures of Harvard students by decade of birth. Beginning with 1856-65 and continuing by decades up to 1906-15, the average statures are as follows: 5′ 8″, 5′8⅔″, 5′9″, 5′9½″, 5′9⅘″, and 5′10″. Sons compared with fathers increased 1.38 inches in height, gained 10 pounds, developed broader shoulders and narrower hips. College girls compared with their mothers added 4 pounds to their weight and 1.15 inches to their height. They have expanded around the waist by almost an inch and a half (from 24.2 inches to 25.65 inches) and around the hips by less than one-half inch (from 36.35 to 36.8 inches), although the hips have actually decreased in width by an inch. The daughters also seem better developed in other ways too. They have chests that are an inch greater in circumference and are capable of a greater expansion. Their arms are slightly larger in girth, presumably being more muscular.

This is far from being an isolated phenomenon, confined to the college population and restricted to those born in specially favorable circumstances. Neither is it characteristic only of one stock in our national "melting pot." College records from north, south, east, and west, from endowed, expensive schools and from state universities parallel the trends uncovered in the Harvard sample. Growth studies on children repeated on the same population after the lapse of a generation or more disclose the same marked increases. Mothers who buy for Johnny aged four, suits sized for age 6 or 7, know this without benefit of science. Children are growing at an accelerated pace and reaching within the growth span a greater size. Since all parts of the body do not continue to grow at the same rate but follow a gradient, certain alterations in proportion follow upon this expansion in height.

So far as the evidence is available, this progress, if one may call it that, of the American type affects all our population regardless of origin. As long ago as 1912, Professor Franz Boas published his inquiry into the effects of the American environment on the bodily form of recent immigrants. He found that the children born in the United States of European immigrants were appreciably modified from the norms of their parents. My own investigation on the Japanese in Hawaii, although concerned with a different stock, led me, after controlled comparisons with the sedent population in Japan, to conclude that physical type is plastic under changes in environment and capable of significant alterations in size and proportion.

As a result of this increasing stature of the American people, both the new and older stocks, our average now surpasses those of the various European countries from which our population is derived. It should not, however, be assumed that the people of the United States alone are undergoing this expansion in height. In various parts of Europe, in Japan, and in other areas where statistics are available, the same process seems to be affecting mankind. Here in Amer-

ica it is apparently accelerated but not unique.

Even if this trend should appear desirable and we take pride in our rising statures, we should soon reach a point where further increases would become rather alarming. If stature has been increasing steadily for the past 75 or 100 years and our college men already have attained a mean of 5 feet 10 inches, where will it all end? Are we experiencing a transformation into giantism, with averages of 6 feet 6 inches or 7 feet within several hundred years or so? Are we headed for ungainly dinosaurian proportions that will lead to our extinction? Professor Mills, of Cincinnati, says no. His recent analysis of the latest data reveals a slowing down of the process, which presumably means a stabilization or possibly a reversal in the trend.

The precise cause of our increase in size is not completely understood. It has been attributed to a variety of factors, among others to improved nutrition, better care of our young, and advances in public health. But none of them seems entirely satisfactory since some of the tallest men in our army of 1917-18 came from areas that enjoyed none of the advantages in nutrition, medical care, and public health that we often think are typical of all parts of the United States. That nutrition, for example, does influence the growth cannot, on the other hand, be denied. Numerous studies on growth agree that children on better regimens do grow more rapidly and attain greater size than their less fortunate fellows. We are probably confronted here with a complex phenomenon which defies an explanation based on a single variable.

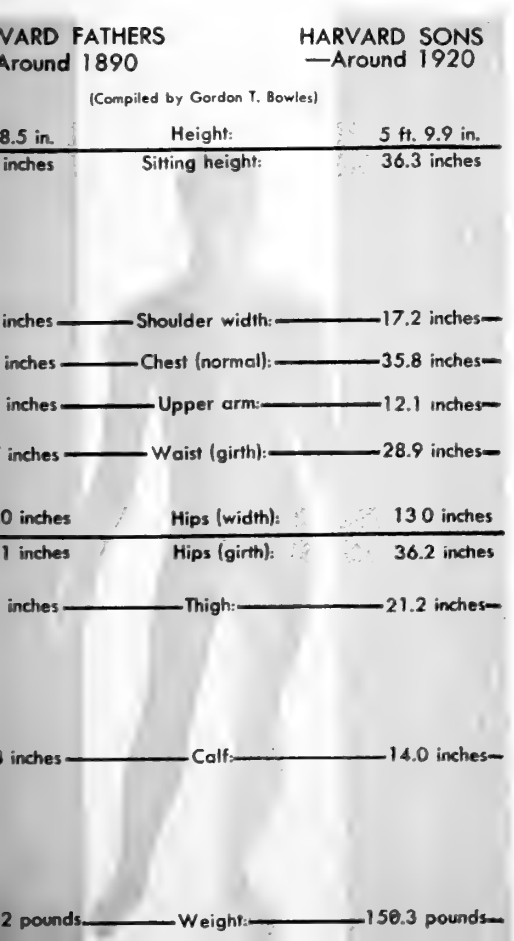
It may well have occurred to the reader by this time to wonder how far the American people are evolving a characteristic American type fundamentally distinct from those of our European contemporaries. Indeed, it was firmly believed at one time that Americans were gradually assuming the aspect of an Indian, on the hypothesis that the same environment that produced our predecessor was transforming us into his simulacrum. Peter Kalm, the Swedish botanist who visited the United States in the middle of the eighteenth century, professed to find "that the French, the English, Germans, Dutch, and other Europeans, who have lived for several years together in distant provinces, near and among Indians, grow so like them, in their behavior and thoughts, that they can only be distinguished by the difference of their colour." But even this surviving mark of distinction was thought by some to be disappearing. The president of Princeton College, Samuel Stanhope Smith, D.D., observed in 1788 that a change had already become manifest in the Anglo-Saxon and other European inhabitants of America, both in complexion and feature, and he further maintained that if the colonists were thrown like the Indian into a state of absolute "savageism" they would soon be marked by the same complexion.

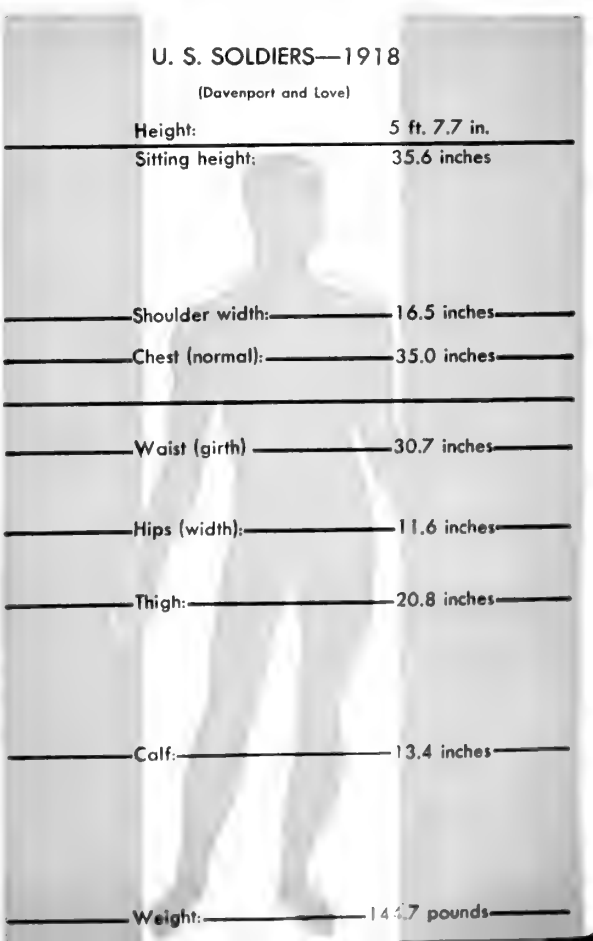
This belief seemed to enjoy a persistent adherence, because as late as the middle of the nineteenth century Dr. Carpenter, writing in an English cyclopedia remarked, "It has not been pointed out, so far as the writer is aware, by any ethnologist, that the conformation of the cranium seems to have undergone a certain amount of alteration, even in the Anglo-Saxon race of the United States which assimilates it, in some degree, to that of the aboriginal inhabitants. Certain it is, that among New Englanders more particularly, a cast of countenance prevails, which usually renders it easy for any one familiar with it, to point out an individual of that country in the midst of an assemblage of Englishmen. . . . And it is not a little significant, that the well marked change which has thus shown itself in the course of a very few generations, should tend to assimilate the Anglo-Saxon race to the aborigines of the country."

So do errors reverberate down the corridors of time. An echo of this strange doctrine came to my ear not very long ago via a well known professor of English literature who repeated this fantasy with complete conviction. If this were indeed true, then those who, referring to the United States, have urged that we "give it back to the Indians" might have been speaking with more poetic justice than they expected. But any such fanciful notion must be laid aside. The American of today remains a close derivative of the stocks that have settled here, but he has at the same time undergone modifications from his ancestral types. His deviations from European norms are either the results of mixture among the various representatives of Old World types or the consequence of an increased size with the attendant changes in bodily proportion that follow on such a quantitative expansion.

HARVARD SONS were ten pounds heavier than their fathers, 1.4 inches taller, and had shoulders 4/10 inch wider

THE SOLDIER of 1918 was shorter and lighter than the Harvard student but had a larger waist. Figures for the soldier of 1945 are not available





Birds of Paradise

By Ernst Mayr

THE AMERICAN MUSEUM OF NATURAL HISTORY

No. 127

Birds of Paradise

By

ERNST MAYR

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THE AMERICAN MUSEUM OF NATURAL HISTORY

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A M.N.H. photo

Deep in the jungle's forbidding wilderness, these magnificent creatures enact a drama of enchanting beauty. Centuries of search have revealed their secrets, and now the finest existing collection enables the American Museum to offer the public a spectacular new exhibit

Birds of

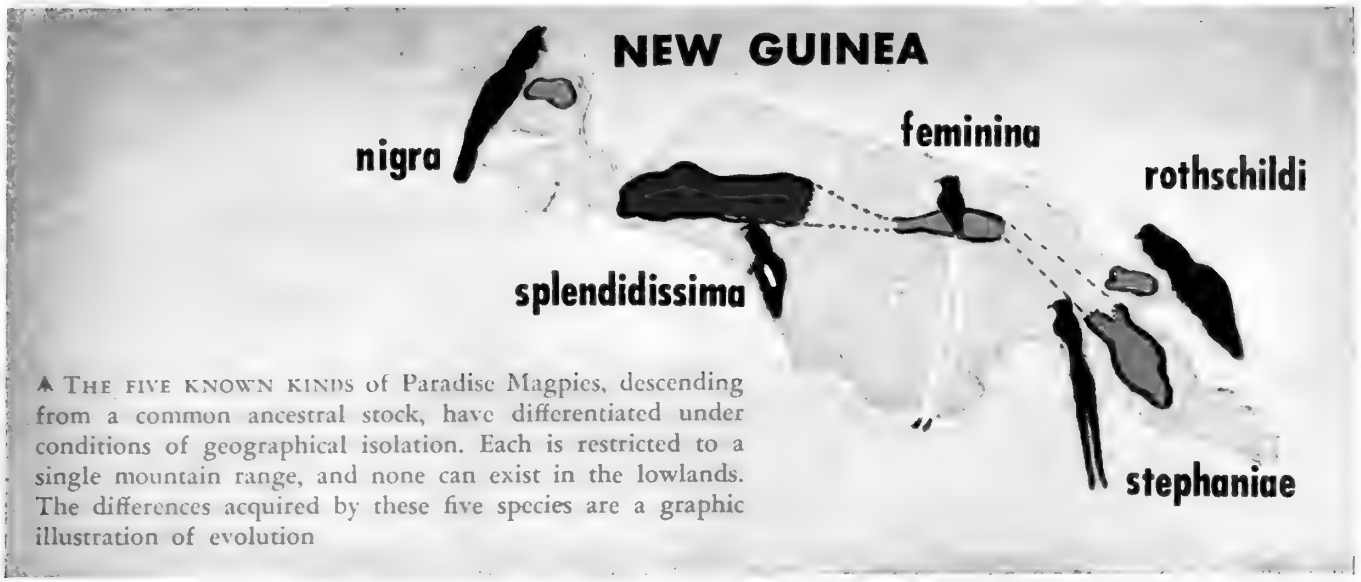
By ERNST MAYR

Curator of the Whitney-Rothschild Collections, American Museum of Natural History

▲ GREATER SICKLE-BILL (*Epimachus fastosus*). In its display the male resembles a long-tailed giant butterfly. Although restricted to the mountain forest above 5000 feet in western and central New Guinea, this bird was already known to the eighteenth century naturalists through skins collected by the natives

THE birds of paradise richly deserve the epithet "the most beautiful birds in the world." Theirs are not only exquisite colors, such as oranges, greens, blues, and reds of many shades, combined in harmonious patterns; what gives them their real distinction is their plumes. The many shapes into which Nature has been able to mold their feathers are a constant source of amazement. There are the true plumes of the genus *Paradisaea*, which surpass the feathers of egrets in soft daintiness. Others have the prismatic sparkle of highly polished metal, their reflections changing with the angle of the light to pass through the whole spectrum of the rainbow. The Superb Bird of Paradise has a velvet cape of softness and dignity to make every well-dressed lady envious. The most astonishing feathers of all are the plumes of the King of Saxony's Bird of Paradise. This bird is no larger than a small thrush, but it produces on either side of its head a thin "feather" a foot and a half long, whose simple wirelike shaft is bedecked on one side with two-score little horny plates like silvery-blue flags.

So extraordinary is the plumage of these birds, which are found nowhere outside the New Guinea area, that some were known to Oriental traders and seafarers centuries before the actual discovery of their native home. As a result, some fantastic ideas grew up about the birds. The first skins to reach Europe were brought by El Cano who, after the death of Magellan, took over the command of the first circumnavigation of the globe. At the small Moluccan Island of Tidore, the Rajah of Batjan presented him with several bird of paradise skins, which reached Spain on September 6, 1522. These skins had been prepared by New Guinea natives in the customary way by taking out the body, cutting off the legs, and drying the skin over a fire. The curious legless skins with the beautiful long plumes led to some amusing stories. Girolamo Cardano, for ex-



▲ THE FIVE KNOWN KINDS of Paradise Magpies, descending from a common ancestral stock, have differentiated under conditions of geographical isolation. Each is restricted to a single mountain range, and none can exist in the lowlands. The differences acquired by these five species are a graphic illustration of evolution

Paradise

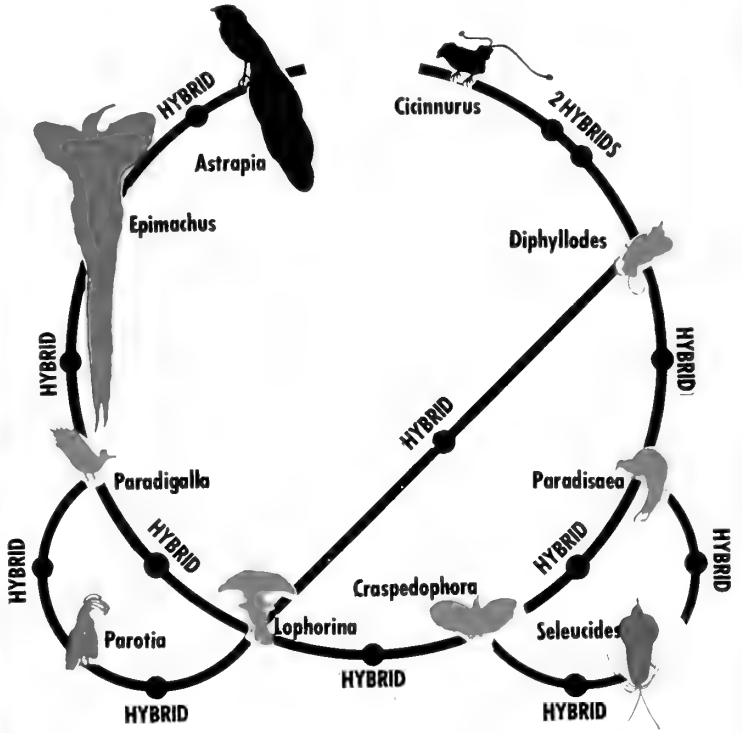
ample, wrote in 1551: "The 'Birds of the Gods' come from the Moluccas where they are picked up dead on land or in the sea. They are never seen alive. Since they lack feet, they are obliged to fly continuously and live therefore in the highest sky far above the range of human vision . . . the back of the male is hollowed out and the female lays her eggs into this cavity and incubates them while the male continues flying . . . they require no other food or drink than dew from Heaven." The name Bird of Paradise was given them in the belief that Paradise was their true home.

At this time their plumes were already in use as customary ornaments by the Janizaries of the court of the Sultan of Turkey, as reported by Belon (1546-1549). The first (and very inadequate) illustration of a bird of paradise was published by the Swiss naturalist Gesner in 1555. All these early reports seem to refer to the Greater Bird of Paradise (*Paradisaea apoda*). In 1605, Charles L'Ecluse was already able to give a short but accurate description of three

▼ EMPEROR WILLIAM'S BIRD OF PARADISE (*Paradisaea guilielmi*). At the climax of its courtship display, the male hangs upside down

A.M.N.H. Kodachrome

▼ TEN of the 20 genera of birds of paradise are known to cross and produce hybrids, as shown by this diagram. Two of these (in black) cross with species of only one other genus. Three of them (in blue) cross with two. Four of them (red) cross with three. The Superb Bird of Paradise (yellow) is known to produce hybrids with four other genera. (The colors are represented arbitrarily)



▲ SWAMPY LOWLAND FORESTS, particularly with sago palms, are the favorite haunt of the Twelve-wired Bird of Paradise. When exposed to the sun, the delicate orange of the plumes bleaches to white. The female is plain: brown and black above, barred buff and brown below

A.M.N.H. photos

➤ A NEW MUSEUM EXHIBIT OF "RIFLE BIRDS," as the black birds of paradise, with velvety and iridescent colors, are sometimes called. As if to make up for the simplicity of their black dress, these birds have developed some of the most bizarre ornamental plumes known among birds

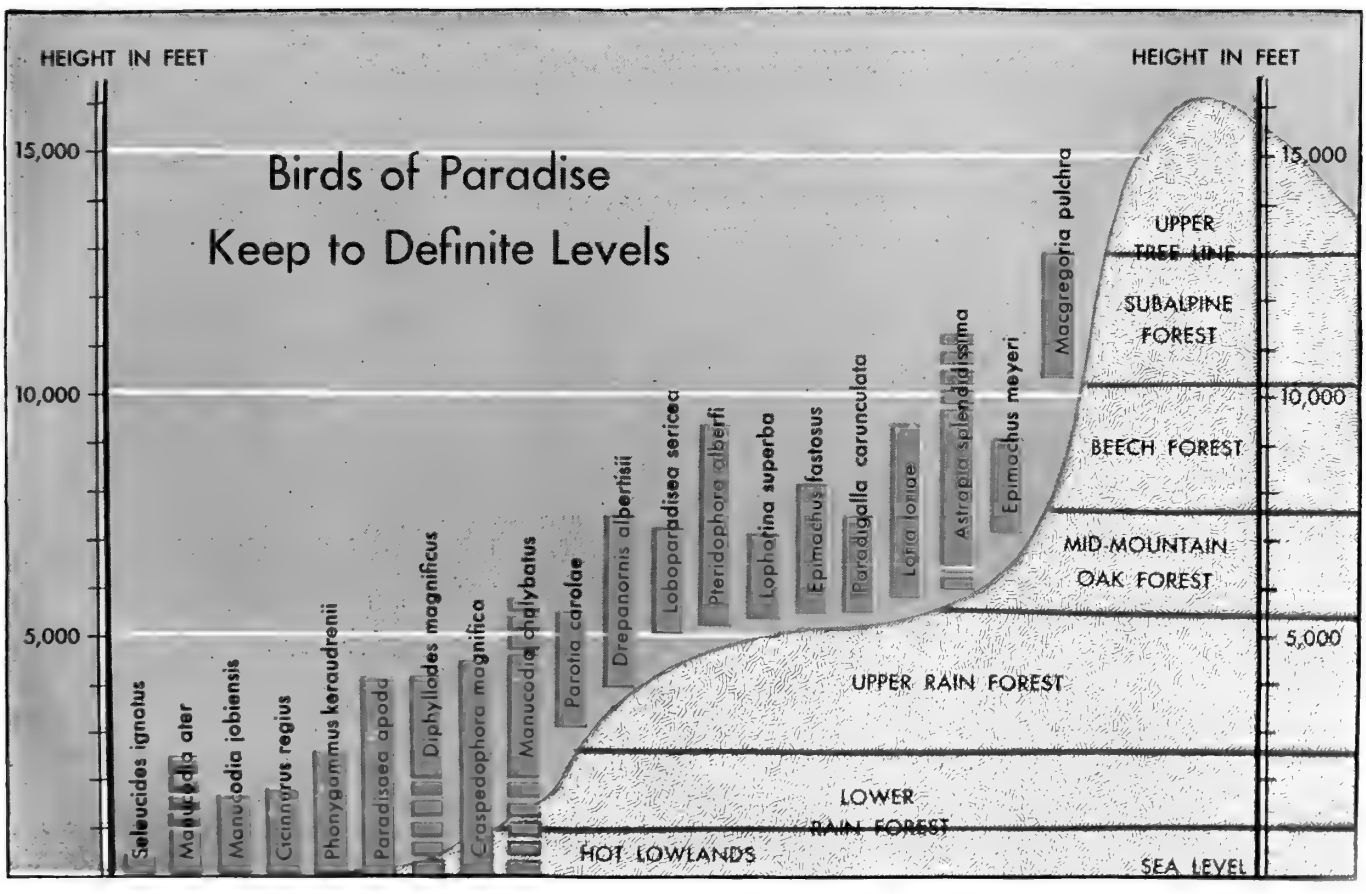
BIRD OF PARADISE eggs are mostly orange streaked with brown. ose of six different species are reproduced here in actual size. At er left is the Twelve-wired Bird of Paradise. Right upper and er are the Australian Rifle Bird and the Paradise Magpie respec-ly. The other three are Plume Birds. (Actual size.)

After Ernst Hartert, in Novitates Zoologicae

A.M.N.H. Kodachrome

▲ THE LESSER BIRD OF PARADISE (*Paradisaea minor*) was one of the most important "plumed birds" of the feather trade. Countless thousands were killed annually early in this century to adorn ladies' hats. Groups of males have "dancing parties" in a favorite tree where they display their plumage in an effort to win the favor of visiting females

BIRDS OF PARADISE are restricted to definite elevations like all animals. he chart below shows the ranges of 20 species in relation to the zones of egetation on the slope of the Snow Mountains in South New Guinea



A.M.N.H. Kodachrome

▲ THE BLUE BIRD OF PARADISE (*Paradisaea rudolphi*) is named in honor of the ill-fated Archduke Rudolph of Austria. It is found only in the mountains of southeast New Guinea. In its upside-down display it spreads its delicate blue plumes fanlike

species, but François Valentyn (1726) was the first to describe in detail the plumage, habits, and distribution of six species. Since then, the exploration for birds of paradise has made rapid progress. A new species was discovered in the interior of New Guinea as recently as 1938.

The thrill of the search for birds of paradise was conveyed by the celebrated naturalist Alfred Russel Wallace, writing from Aru almost one hundred years ago: "The first two or three days of our stay here were very wet, and I obtained but few insects or birds, but at length, when I was beginning to despair, my boy Baderoon returned one day with a specimen which repaid me for months of delay and expectation. It was a small bird, a little less than a thrush. The greater part of its plumage was of an intense cinnabar red with a gloss as of spun glass. On the head the feathers became short and velvety and shaded into rich orange. Beneath, from the breast downwards, was pure white, with the softness and gloss of silk, and across the breast a band of deep metallic green separated this color from the red of the throat. Above each eye was a round spot of the same metallic green; the bill was yellow, and the feet and legs were of a fine cobalt blue. . . . Springing from each side of the breast, and ordinarily lying concealed under the wing, were little tufts of grayish feathers about two inches long and each terminated by a broad band of intense emerald green. These plumes can be raised at the will of the bird and spread out into a pair of elegant fans when the wings are elevated. But this is not the only ornament. The middle feathers of the tail are in the form of slender wires about five inches long, which diverge in a beautiful double curve. About half an inch of the end of this wire is webbed on the outer side only and colored of a fine metallic green and, being curled spirally inward, form a pair of elegant glittering buttons, hanging five inches below the body and the same distance apart. These two ornaments, the breast fans and the spirally tipped tail wires, are altogether unique, not occurring on any other species of the 8000 different birds that are known to exist upon the earth. . . . My transports of admiration and delight quite amused my Aru hosts who saw nothing more in the "Burong rajah" than we do in the robin or the goldfinch.

"Thus one of my objects in coming to the Far East was accomplished. I had obtained a specimen of the King Bird of Paradise (*Paradisea* [*Cicinnurus*] *regia*), which has been described by Linnaeus from skins preserved in a mutilated state by the natives. . . . The emotions excited in the mind of a naturalist, who has long desired to see the actual thing which he has hitherto known only by description, drawings, or badly-preserved external covering—especially when that thing is of surpassing rarity and beauty—require the poetic faculty fully to express them. The remote island in which I found myself situated, in an almost unvisited sea, far from the tracks of merchant fleets and navies; the wild, luxurious tropical forest, which stretched far away on every side; the rude, uncultured savages that gathered round me—all had their influence in deter-

mining the emotions with which I gazed upon this "thing of beauty." I thought of the long ages of the past, during which the successive generations of this little creature had run their course—year by year being born and living and dying amid these dark and gloomy woods, with no intelligent eye to gaze upon their loveliness; to all appearance such a wanton waste of beauty. Such ideas excite a feeling of melancholy. It seems sad that on the one hand such exquisite creatures should live out their lives and exhibit their charms only in these wild, inhospitable regions, doomed for ages yet to come to hopeless barbarism; while on the other hand should civilized man ever reach these distant lands and bring moral, intellectual, and physical light into the recesses of these virgin forests, we may be sure that he will soon disturb the nicely-balanced relations of organic and inorganic nature as to cause the disappearance and finally the extinction of these very beings whose wonderful structure and beauty he alone is fitted to appreciate and enjoy. This consideration must surely tell us that all living things are *not* made for man. Many of them have no relation to him. The cycle of their existence has gone on independently of his and is disturbed or broken by every advance in man's intellectual development; and their happiness and enjoyments, their loves and hates, their struggles for existence, their vigorous life and early death, would seem to be immediately related to their own well-being and perpetuation alone, limited only by the equal well-being and perpetuation of the numberless other organisms with which each is more or less intimately connected."

The writer is often asked by would-be young explorers what chances there are for the discovery of new birds of paradise. Crystal gazing is not my profession, and the only answer I can give to such a question is based on an estimate of probabilities. Since 1910, only one good species of bird of paradise has been discovered, and even that is a geographical representative of three other mountain species that had long been known. I would judge, therefore, that the chances are exceedingly slight. However, it is a virtual certainty that unknown *races* will be discovered in the unexplored mountains in the interior of New Guinea. As late as 1929, I discovered a new race of the little Golden Silky Bird of Paradise (*Loboparadisea*) in the Herzog Mountains, near Lae of recent battle fame, a species previously known only from the Snow Mountains of Netherlands New Guinea.

The most striking discovery of recent years was the male of the Ribbon-tailed Paradise-Magpie in 1938, of which the inconspicuous-looking female had been known already for 25 years. This magnificent bird has two extremely long silky-white central tail feathers with black tips. The rest of the plumage is black and dark green, the glossy parts sparkling in all the colors of the spectrum. It is not surprising that this bird has escaped discovery so long, because its range lies in the most inaccessible part of central New Guinea, in the mountains between the headwaters of the Fly and Sepik Rivers. While most or all of the species are known, so little is known about their habits and life history that any student is sure to make his share of discoveries. There are at least ten species whose habits are still completely unknown.

A.M.N.H. PHOTO

▲ THE SUPERB BIRD OF PARADISE (*Lophorina superba*) has two sets of plumes. One is a breast shield of a glossy green; the other is a cape of velvety black feathers which can be raised over the head. The inside of the mouth is brilliant yellow and is displayed prominently against the background of the raised black cape

Elusive birds of paradise

One reason why Lord Rothschild asked me, in 1927, to go to New Guinea was to search for the so-called "rare birds of paradise." This term has a special meaning. In the days when the plume trade was flourishing, tens of thousands of bird of paradise skins went every year through the hands of the great plume dealers in the Indies, Paris, Amsterdam, and London. These dealers, among whom the Dutchman Duivenbode and the French dealer Mantou were best known, discovered each year in their shipments from New Guinea a few skins that did not seem to belong to any known species. Lord Rothschild and other collectors were willing to pay fabulous prices f

these specimens, which they subsequently described as new species. In later years, it was discovered that some of these skins had come by devious channels from inaccessible mountains in remote parts of New Guinea. More than a dozen of these species, however, defied all the efforts of even the most resourceful hunters. Lord Rothschild did not give up hope, however, and when he sent me to New Guinea it was in the expectation that the home of these rare species would eventually be discovered. I was to make a thorough survey of a number of isolated mountain ranges in that region.

I had a most successful expedition in every way except with respect to Lord Rothschild's pet project. I did not rediscover a single one of the rare birds of paradise. My failure to do so, however, was indirectly responsible for the eventual solution of the puzzle. It set Professor Stresemann of the University of Berlin on the track of these birds, and by a careful study of the museum specimens he came to the conclusion that all the fifteen rare birds of paradise, whose homes could not be discovered, were actually hybrids of well-known species. This conclusion is now universally accepted.

Frequency of crossing

The question has often been asked why hybrids are so common among birds of paradise. But are they really common? If one or two such hybrids were culled out of an annual crop of 30,000 to 50,000 plumes, it would mean that only one out of 20,000 birds is a hybrid. This is certainly not a very high ratio. Even so, there is reason to believe that it is higher than among most other birds. The reason is obvious as soon as we recall the breeding habits of these birds. The nestling female bird never sees her father, and her younger brothers as well as her mother are of a simple coloration, totally unlike that of the adult male. The mature female is attracted to the display ground when she is ready for mating and leaves the male soon after. It is only to be expected that she will accept a mate of another species oftener than will females of species in which the members of a pair live together for days, weeks, or months before the actual start of reproduction.

The American Museum's collection of birds of paradise was very meager until about twenty years ago. Dr. Leonard C. Sanford, generous trustee of the Museum, who has done so much to build the Bird Department, was fully aware of this deficiency. In 1928, he sent Rollo H. Beck to northeast New Guinea and the writer to Dutch New Guinea to fill some of the gaps, and in 1929 they were followed by the Whitney South Sea Expedition, sponsored by Harry Payne Whitney, which concentrated on British Papua.

The result of these efforts was the finest collection of birds of paradise to be found in America but, alas, still a very poor second to the famous collection in the private museum of Lord Rothschild in England. This collection, resulting from 40 years of concentrated effort, contained nearly every known kind of bird of paradise, including about seventeen that were for the first time described by Lord Rothschild himself. Furthermore, this collection was of inestimable scientific value, because it contained large numbers of young, female and male birds in various stages of molt, giving a complete picture of variation and evolution in this wonderful group.

It seemed utterly beyond our fondest hope that the American Museum should ever come into possession of such a magnificent collection. It was therefore an overwhelming surprise when in 1932 Lord Rothschild offered his entire collection for sale and Mrs. Harry Payne Whitney seized the opportunity to donate it to the American Museum. It gives this institution by far the finest representation of birds of paradise existing in the world. It has since been augmented through the explorations of Richard Archbold and his associates.

Although primarily a research collection, the Museum has long felt that visitors would appreciate a public exhibit of birds of paradise, presenting the latest information on the remarkable displays of these birds. Through the interest and generosity of Colonel C. V. Whitney, it has been possible to carry out plans for such an exhibit, originally conceived by Dr. Sanford. Most of the illustrations on the accompanying pages are based on photographs of these new exhibits in Whitney Memorial Hall at the American Museum of Natural History.

Birds of paradise are believed to be resplendent relatives of the crow family. Indeed, the most primitive birds of paradise, the four species of manucodes, look very much like small crows, except that the plumage has a more pronounced purplish or bluish sheen. Males and females in this group are colored alike, although the males are slightly larger. Most persons would hardly believe that these plain birds are birds of paradise. Yet they are connected with the more bizarre types by an unbroken series of intermediate forms.

Recent students recognize 39 species and 59 subspecies of birds of paradise, grouped in twenty genera. The ornithologists of the nineteenth century had the habit of naming newly discovered birds of paradise for the crowned heads of Europe, to honor them and perhaps to please them sufficiently for a raise in the annual appropriation for their respective museums. This custom displeased the French ornithologist Charles Louis Bonaparte, nephew of Napoleon. When he finally had a chance to name a newly discovered bird, he called it "A Republican Bird of Paradise" with the following amusing explanation:

"Since I for my person have not the slightest regard for the sovereignty of all the princes in the world, I have adorned the most exquisite bird of paradise with the name of the Republic: that Republic which would be Paradise, if it had not been turned into Hell by evil tricks and through the ambition of so-called Republicans unworthy of the name they claimed for themselves. . . . However, even though a paradisean Republic does not exist, at least there is now a *Paradisea respublica* (a Republican Bird of Paradise)."

Unfortunately there are no good English names for about eleven of the groups in which the known 39 species may be divided. The brightly colored ones are sometimes referred to as "plume birds," and the black ones with metallic feathers as "rifle birds," but this classification of convenience oversimplifies matters. A diagram reproduced on page 274 shows the family tree of the birds of paradise and divides them into a few convenient groups.

No less bizarre than the plumes of the birds of paradise are their courtship habits. To be sure, there are a few species that live a very conventional and proper family life. It is more than a coincidence that these same species lack the extraordinary plumes and color. The manucodes

are black with a greenish blue or purple gloss. Both mates co-operate in the building of the nest and in raising the young. If these birds behave like their close relatives, the crows, it will be found that the female alone incubates the eggs. No observations on this point are yet available. The males, however, have one very extraordinary feature: their trachea, or windpipe, is more than twice the normal length and is coiled up in a big loop on top of the breast bone.

Recent observations by Dr. Rand indicate that in Macgregor's Bird of Paradise the male also participates in the raising of the young. In all other species, so far as we know, the female is alone and completely responsible for the cares of nest building, incubation, and feeding the young. The males devote their entire existence to feeding and courtship. No wonder they have enough surplus energy to develop their famous plumes as well as to engage in all sorts of odd performances.

It is by no means easy to observe birds of paradise in the wild. Their complicated display poses, therefore, have first been described chiefly from zoological garden specimens. Captivity does not seem to interfere with the normal course of their behavior. It seems that a bird in a cage will go through the same motions he would in nature. What the captive specimens do not tell, however, is whether the courtship is solitary or communal.

On the basis of my own observation, I would say that the display of most of these birds is solitary. Exceptions are the true plume birds (*Paradisaea*) and perhaps the flag birds (*Parotia*). Dr. Rand has added to this category Macgregor's Bird of Paradise, whose males engage in communal courtship chases.

Special "dance floors"

The flag birds, which are limited to the unbroken mountain forests, clear a piece of ground as their "dance floor." There must be a number of low horizontal twigs on which the birds strut. Coming on one of these clearings in the forest, I could always tell whether it belonged to a *Parotia* by the presence of these horizontal branches. There is another bird of paradise that lives in much the same surroundings and prepares little clearings on the forest floor. It is the Magnificent Bird of Paradise. However, most of its perches are vertical—numerous small saplings, at least partly stripped of their foliage. The male performs its curious display while climbing up

A.M.N.H. photos

▲ THE PARADISE MAGPIE (*Astrapia atra*) leads a solitary life in the mountain forest. It does not indulge in spectacular displays

◀ THE LONG-TAILED FLAGBIRD (*Parotia wahnesi*) is restricted to the Huon Peninsula. The Flagbirds are also sometimes called the Six-wired Birds of Paradise

▲ WALLACE'S STANDARD-WING (*Semioptera wallacei*) lives in the Northern Moluccas. Most of the plumage is pale brown, but the triangular breast shield is brilliant green. The ribbonlike plumes, or "standards," are raised in the display

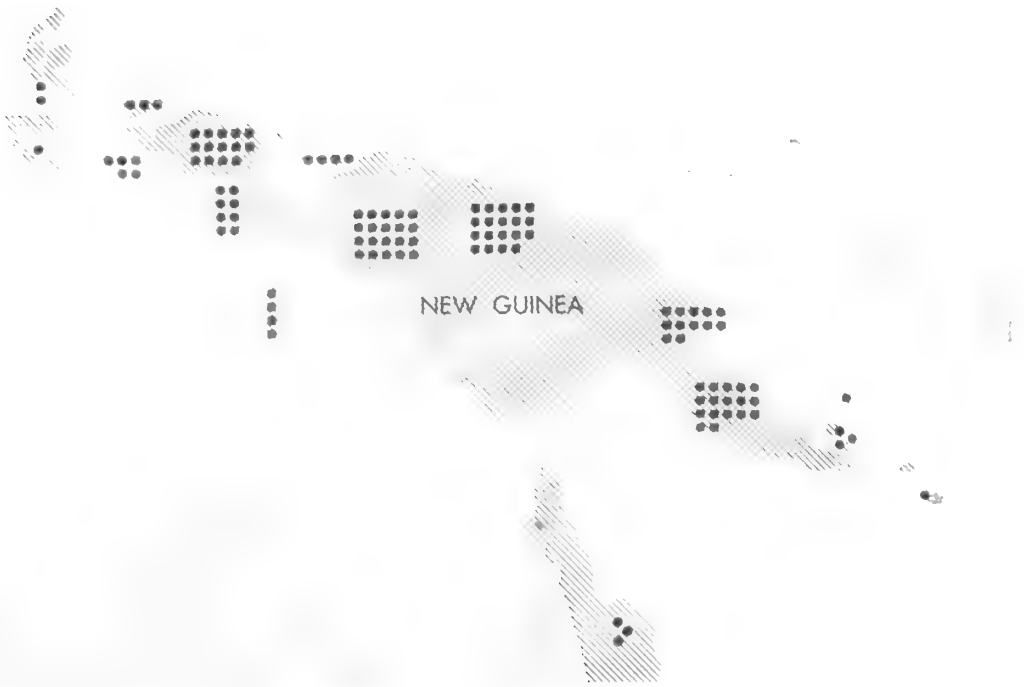
▼ THE PLUMES of the King-of-Saxony's Bird of Paradise (*Pteridophora alberti*) are considered the most peculiar feathers to be found in the bird kingdom. This is a rare bird of the mountain forest in central New Guinea

▲ THE KING BIRD OF PARADISE (*Cicinnurus regius*) is also called Money-bird because of the coinlike tips on the long wirelike plumes. This is a common bird of the lowland forest

▼ THIS MALE of the Magnificent Bird of Paradise displays in an almost upsidedown posture to a female perched above him on the same sapling. Note the raised ruff and the wirelike plumes

A.M.N.H. photos

▼ THE RANGE of the bird of paradise family. Each group of dots indicates how many kinds of birds of paradise might be found in a cross-section as shown at the foot of page 265

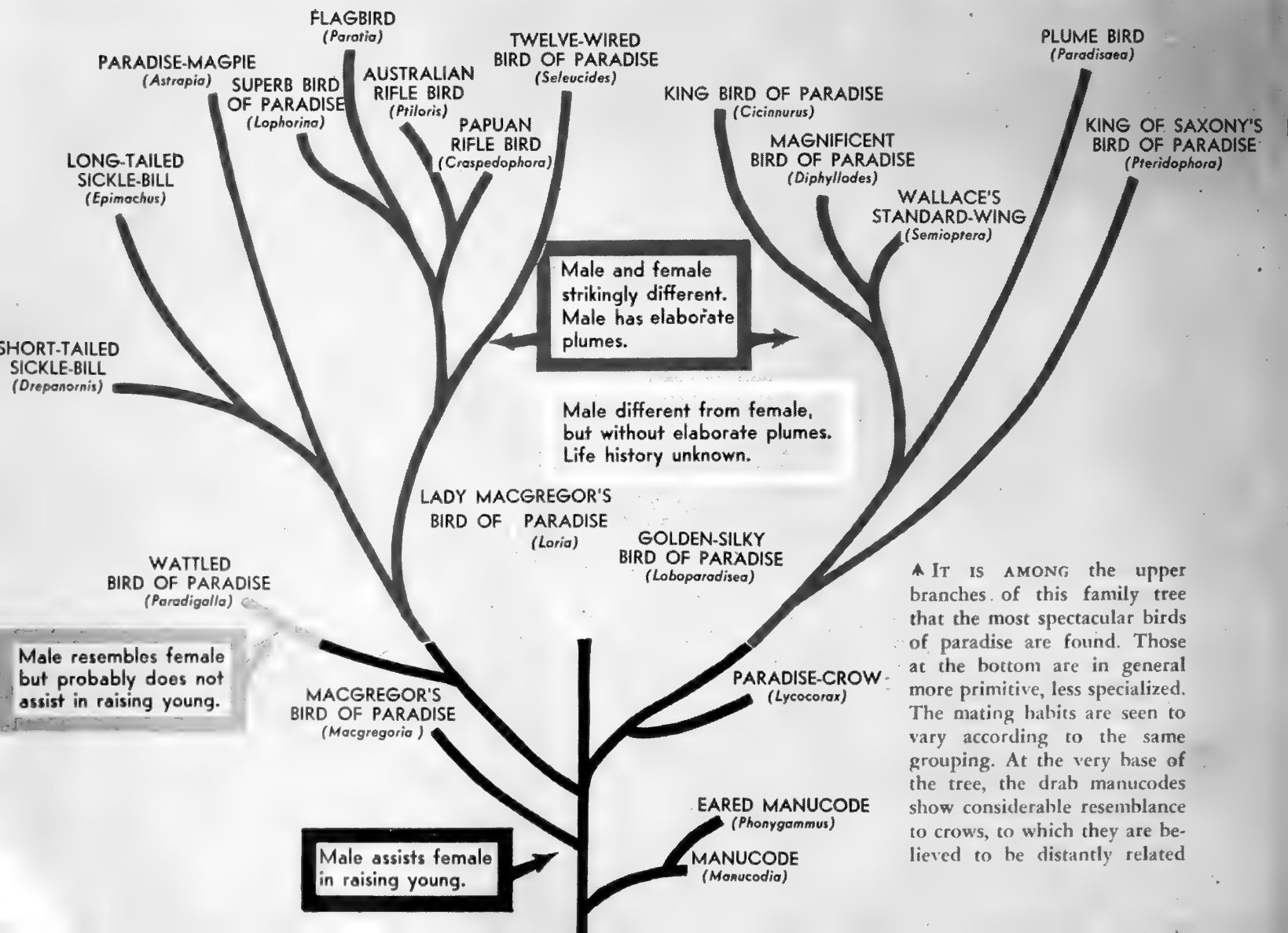


and down these vertical perches. A single male owns each of these display grounds and guards it jealously against any intruder of the same sex, as described by Dr. Rand in NATURAL HISTORY for March, 1940.

These seem to be the only birds of paradise that have regular display grounds. All the others may well have a favored tree or even a perch, but it looks like any other in the forest.

Their future

With heavy fighting going on in New Guinea and with hundreds of thousands of troops stationed along its shores, one may ask whether or not the existence of these birds is threatened. Some apprehension is not unjustified in view of the restricted ranges of the various species. Still, I feel that no danger exists at present and that the birds of paradise will continue to survive and even to flourish, provided no additional danger develops. Two factors, more than anything else, are likely to cause ex-



▲ IT IS AMONG the upper branches of this family tree that the most spectacular birds of paradise are found. Those at the bottom are in general more primitive, less specialized. The mating habits are seen to vary according to the same grouping. At the very base of the tree, the drab manucodes show considerable resemblance to crows, to which they are believed to be distantly related

tinction, as shown by the history of birds in New Zealand and Hawaii. One is the destruction of habitat, the other the introduction of alien species. These latter act either as predators, as competitors, or as carriers of diseases and parasites. In view of the vastness of New Guinea forests, the efforts of conservation should be directed principally against voluntary or accidental introduction of alien species.

That even heavy hunting in an undisturbed habitat does not necessarily lead to extinction is well illustrated by the history of the plume trade, which began, at least in a small way, fully 500 years ago. As more and more white people settled in the East Indies, the demand for plumes rose. Finally, enough of them were imported to Europe to attract the attention of fashion designers. The plumes were featured on ladies' hats, and fabulous prices were paid for them. Wallace describes how the natives of Aru hunted the birds around the middle of the last century: "They shoot the birds with a bow and arrow, the arrow having a conical wooden cap to the end as large as a tea cup, so as to kill the bird by the violence of the blow without making any wound or shedding any blood. The trees frequented are very lofty; it is therefore necessary to erect a small leafy covering or hut among the branches, to which the hunter mounts before daylight in the morning and remains the whole day, and whenever a bird alights they are almost sure of securing it."

Beginning about 1880, the hunting of birds of paradise developed into a prosperous trade and reached a peak about 1910. Malay and Arab plume hunters penetrated far into the unexplored regions of Dutch New Guinea and along the coast. Whole towns subsisted on the plume trade. Hollandia was a town of 700 in 1923. In addition to the Malay hunters and their Papuan companions, there were Chinese, Arab, and Dutch traders. The prohibition of hunting in 1924 brought about a slump, and when I visited the region in 1928, Hollandia was a regular ghost town of only 30 or 40 people, like some of the famous mining settlements in the West.

➤ A PAIR of Magnificent Birds of Paradise in courtship. The male is in the full glory of his display, with his velvety shield glistening like burnished metal and his yellow cape thrown forward

Drawing by B. F. Chapman

The hunting of the plume birds was a strictly seasonal affair. Though male birds of paradise do not have a regular eclipse plumage like certain ducks and passerine birds, they have to go through an annual molt like all birds. Naturally, the plumes are in best condition shortly after this molt. The Malays knew by experience when that date was reached and fixed on it the opening of the season. Hundreds of small expeditions then left the coast to settle in some village in the interior, which served as the base of operations. From here every morning, Papuan hunters went to the neighboring forest to hunt for males in full plumage.

After several months, when all the trade goods had been exhausted and all the adult males in the neighborhood collected, the little expedition made its way back to the coast. Here great celebrating took place, and I am told that between gambling and drinking many of the Malays lost all their hard-won gains within a period of a few weeks.

In former German New Guinea and in the Australian part of New Guinea, the hunting was usually in the hands of the white residents. The hard-struggling colonists found in this trade a means of support while waiting for their plantations to mature. Most of the plantations in eastern New Guinea grew coconuts, which do not begin to yield profits until they are about 8 or 10 years old. Meanwhile, the plantation labor had to be paid, and in the absence of any other income, the birds of paradise were a lifesaver to many of the colonists. In a few weeks they could collect enough birds to pay for all the expenses for the rest of the year.

The number of skins exported annually from New Guinea was appalling. In 1913, for example, no less than 30,000 birds of paradise appear to have been offered for sale in London auctions. In the years before the last war, around 10,000 birds were exported annually from German New Guinea alone. In a single shipment in 1912, a British firm received 28,300 skins. Some figures indicate that as many as 80,000 were exported from Dutch New Guinea in a single year.

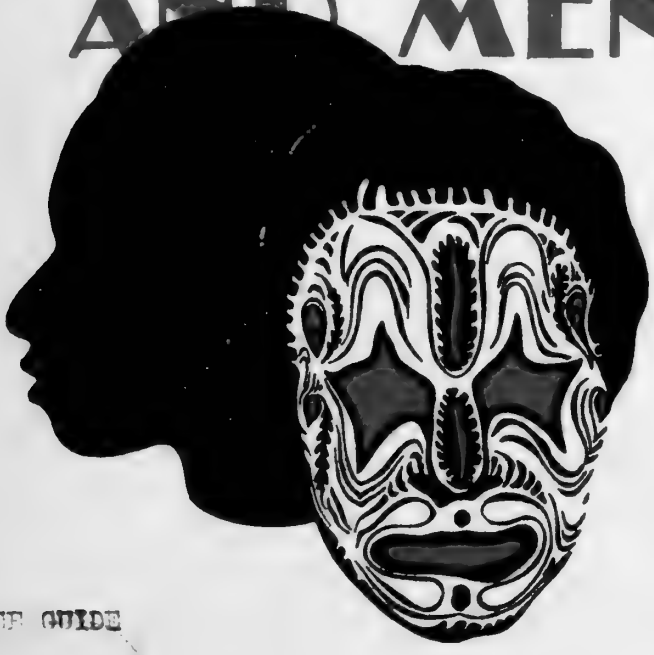
Conservationists throughout the world feared that birds of paradise were definitely threatened, even though the hunters spared the females and immature males and did not hunt out of season. Finally, the season on birds of paradise was closed completely. Since 1924, no birds of paradise have been collected legally, and even the illegal hunting has been negligible. When I visited Hollandia in 1928, I was surprised to discover that birds of paradise were displaying right in the outskirts of the town. There were numerous display trees within a few miles. Obviously, the birds had made a wonderful recovery within only four years. The mountain species, of course, had never been under pressure. If they are scarce in collections, it is either because their habitat is very remote, as in the case of King Albert's Bird of Paradise, or because they are very rare even in nature.

So much for the birds in their natural home. Words can never fully portray their beauty. And for this reason, New York is fortunate in having this new exhibit, in which are displayed a number of outstanding specimens from the world's finest collection, along with related information. It is hoped that many persons will see it.

Ernst Mayr photos

CERTAIN birds of paradise prepare "dancing grounds," in which the male displays his iridescent plumage in an elaborate courtship ceremony. (*Above*) Nicely spaced horizontal branches characterize the dance floor of the Flagbird. (*Below*) Vertical branches are required by the Magnificent Bird of Paradise on which to perform

MASKS AND MEN



SCIENCE GUIDE
No. 128

THE AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK, N. Y.

People in all parts of the world wear masks: to imitate—to disguise—to protect.

To us, masks by themselves are curiosities or works of art. When worn in ritual or festival, however, they evoke vivid emotional responses, both in the wearer and in his audience.

We experience the magic of masking as children at Hallowe'en, and at Mardi Gras and masquerades; also when masks are worn by actors or outlaws.

That same experience has moved man since the days of the ancients.

Eskimo masked dances, like the Athapascan dances, are held to give thanks and win over the thinking spirits of all creatures.

By wearing the mask of a spirit, the dancer assumes its power. During certain religious festivals women dance with small, round masks on their fingers.

As the Eskimo dances the movable parts of his mask sway in time with his body. This is considered an important part of the dance. Music is provided by a solo singer and a background chorus. The rhythm is beaten out on a parchment drum or tambourine.

The spectators, mostly women, add their voices to the chorus. The songs tell either of mythical or real events, based on legends or real hunting or fishing experiences.

The world of the spirits comes to life when these Indians dance at night in huge, shadowy houses barely lit by yellow fire-light. By startling dramatic tricks and sleight-of-hand, masked dancers bring the audience face to face with their spirit ancestors.

These masks are used by medicine men and by clans and secret societies founded and protected by animal spirits. In winter, the secret society dances are the occasion for social life, religious ceremonies, fun and excitement for the people. The dancers enact the founding of the society by animal ancestors who could change to human form and back again. By pulling hidden strings to open and close the double and triple masks, the dancer shows this important change. To the audience, the actors seem to be spirits performing supernatural feats.

CANNIBAL SPIRIT MASK

This is the Cannibal Spirit Mask of the Kwakiutl Indians. The body of the Cannibal Spirit is covered with mouths and his servants catch men and gather corpses for him to eat. In his house live the Cannibal Bear and also the Cannibal Raven who eats the eyes of the men whom his master has eaten. Human beings to whom the Cannibal Spirit appears develop a craving for human flesh.

Among the Pueblo and village Indians of the arid Southwest, ceremonies center about fertility and harvest, rain and growth. The failure or success of crops depends upon the powerful Gods of the Sun, the Earth, the Wind and the Clouds. Kachinas, spirits of the dead, act as go-betweens for these Gods and man. The Kachinas are represented by costumed, painted, and masked men who lose themselves in the personality of the Kachina mask.

The Zuni mask maker sprays his mask with seeds which he has chewed, saying: "Now I have given you life. I have made you with seeds and given you life. Bless us with your strong spirits and whenever our day may come, call the rains for us as long as you live. I have made you into a person."

The Indians of the Southwest attach great symbolic importance to color. Yellow is the color of the moon and the symbol of rain. This Hopi yellow half-mask is worn by female Gods. The Hopi gives the mask life by painting it. So sacred is the paint that when the old color is scraped off it is placed in a Kachina shrine.

HALF-MASK

After the Spanish Conquest, missionaries introduced new carnivals and processions in place of the old Indian dances. Many masks and costly costumes were used to show the Passion of Christ, the Conquest and the battles between the Moors and the Christians.
Today these carnivals are still held. They are social as well as religious and a main amusement of the people.

MATACHINE MASK

Matachine dancers perform at church fiestas and other ceremonies. Eight to twelve men dance to the music of violins and guitars. Faintly resembling the Virginia Reel, the dance is directed by one or two leaders who indicate the figures with a fan held in the left hand.

The dance of the Spanish Conquest is one of the most popular dances in Guatemala.

CONQUEST MASK

Like those of Mexico, the carnivals of Guatemala take as their theme the Spanish Conquest. This mask portrays a European in the Conquest story.

Dance masks are found almost everywhere in South America. In many places they are made only for a special occasion and then destroyed.
In prehistoric times it was the custom to put masks over the faces of the dead.

MUMMY MASK

In Peru from about 1000 to 1400 A.D. the coast people buried their dead in mummy bundles to which false heads were attached. On this false head there was a face, either painted or in the form of a mask made of wood or metal. This mummy mask is made of wood with shell eyes.

In Africa masks have many magical and religious uses. They are worn in the rites of secret societies, in ceremonies initiating boys and girls to adult life, in war dances, and by medicine men in making magic and in curing the sick.

The white masks of the Ibo of Nigeria represent re-embodied spirits who return to earth with white faces. White-masked men called maws run around with whips and sometimes throw down yams as offerings.
The maw usually speaks with a whistling tone, produced by holding in his mouth a small piece of wood with spider webs at each end.

MAW MASK

INITIATION MASK

When Bampende boys enter into manhood they wear an initiation costume and mask during the entire ceremony. During this time they hide in the forest or the bush, keeping out of sight of other people. Women would surely die if they looked upon the masks.

As part of Buddhist ritual, Tibetan temple dances are held to welcome the New Year and to drive out the bad luck demons of the old year. These are the Mystery Plays in which Buddhist monks or lamas wearing awesome masks portray gods and demons. Acting the vivid pageant in the temple courtyard, they show the power of lama and church over demon and human enemies.

HVA-SHANG MASK

Hva-shang, a Chinese monk, came to Tibet in the eighth century. The lamas made him ridiculous in their religious debates. Hva-shang is the "stooge" of the Mystery Play. He is pushed about and forced to worship Tibetan gods, and the audience is delighted when a tray of barley is thrown in his face. Defeated, he staggers from the courtyard.

Actors in Japanese NO and KYOGEN plays are masked. NO is the established drama based on folk tales of Japan and nearby countries. The stage sets, the magnificent costumes, the characters and even their facial expressions are set by tradition. The expressions of the masks correspond to the personality of the characters in the play.

The KYOGEN comedies are shown between the scenes or as part of the NO play.

UZUME MASK

The Sun Goddess once became angry at her brother the Storm God, and retired to a cave in a rage. The anxious people, deprived of the sun, gathered and begged that she come out, but she refused. At last the jolly goddess Uzume came to the cave and did a dance so droll and shocking that all the heaven dwellers burst into laughter and the Sun Goddess forgot her anger and returned to her people.

In Ceylon, masks are worn in the traditional plays and in dances to cure the sick. The theatrical masks represent stylized character types.

The Sinhalese think disease is caused by devils, and a devil dancer wearing a demon mask is called to make a cure. During the ceremony the drums and music grow wilder and wilder and the dance more frenzied. The dancer faints when the demon leaves the sick man to enter his body. The dancer is then carried out as dead and the patient is cured.

GURULA MASK

The sacred eagle Gurula who frees mankind from poisonous snakes is the hero of a popular scene in the dance drama. He appears when the beautiful Serpent Virgin enters the King's court to sing with the people. Gurula flies through the air and, although other snakes come to help the Serpent Virgin, he devours them all and drinks their blood. The mask of Gurula shows him devouring snakes and wrapped in coils of fighting cobras with spread hoods.

The Javanese drama takes its themes from two great mythical cycles of India, the Ramayana and the Mahabharata. Actors at the courts of princes and travelling players have fascinated generations of audiences by the same stories, characters, costumes, music and gestures. The type of mask indicates the kind of character portrayed, God or demon, elegant or coarse, good or evil.

HANUMAN MASK

Hanuman, the General of the monkey army, is the hero of a Javanese play. He helps a royal prince to rescue his kidnapped wife from the clutches of the demon king.

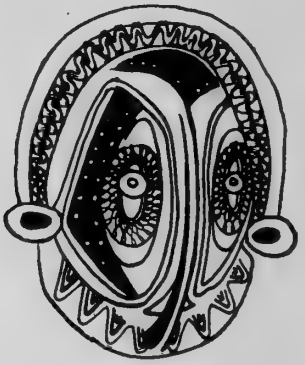
Masked dancers in Borneo act as peace envoys; catch and return the wandering souls of sick people; and insure good harvests by capturing the timid soul of the rice plant at planting time.

RICE
PLANTING
MASK

The Borneo native thinks that rice has a soul and if the soul is not present the harvest will be poor. To get the rice soul back to the fields, figures masked as powerful demons with long wooden hooks dance in a circle before the houses. In the dance they make sweeping movements of the hooks to entice the rice soul, which is timid and easily frightened.

The dancers who perform the ceremony are not allowed to speak. If they spoke they would fall dead since the real demons whom they represent are speechless.

Masks play an important part in the spectacular ceremonies of New Guinea and nearby islands. Between ceremonies the mask lies, sometimes forgotten, sometimes carefully guarded from the uninitiated. It then emerges, repainted and decorated for a new ceremony, to astonish the women and children and renew the men's sense of their own social and religious self-importance.



YAM MASK

Among the plains people of northwest New Guinea, the finest long yams are carried horizontally on poles at harvest time. These yams are treated as supernatural beings, and wear masks, and feather and leaf streamers as decorations.

The American Museum is grateful to the following:

MR. GREGORY BATESON
for scientific advice

KATZENBACH AND WARREN, INC.
for sculptured wall covering

M. SCHWARTZ AND SON
for feathers

THE CEREALS

Science Guide No. 129

AND CIVILIZATION

By Clark Wissler

Curator Emeritus, Department of Anthropology

The American Museum of Natural History

CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y.

McCORMICK-DEERING

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Introduction

THE three great staple food grains used by mankind are wheat, rice and corn (maize). They are of primary importance, so we speak of them as "the big three." The leading secondary grains are barley, rye, oats and millet. A serious world wide crop failure in any one of the "big three" would be a calamity.

All the seven grains we have designated are the seeds of grasses, originally wild. Nature seems to have so ordered the plant coverage of the earth that the grasses were destined to furnish the main foods for man and his herds. The grasses are basic because their stems and seeds sustain the animals upon which man depends for a large part of his daily diet.

In contemporary speech the word *cereals* is used to designate grains when eaten by man—derived from Greco-Roman mythology, the name of the Goddesses Ceres, traditionally responsible for the reproduction and growth of grain crops. However, the recent tendency is to use the word cereals to specify certain breakfast foods, such as cracked wheat, puffed rice, corn flakes, etc., in contrast to breads of various makes.

Civilization first came of age with the cultivation of wheat. Before the dawn of civilization was a long period of twilight during which hunting and gathering wild game, seeds and roots was the way of life. We know this from the study of surviving savages and from archaeology, which teaches us that Australia, for example, never had an ancient civilization, but was a land of savages down to 200 years ago. Science gives us faith to believe that man lived upon the earth more than 400,000 years before it ever occurred to him to sow the wild grass seeds he had long depended upon for survival and that civilization came to maturity less than 10,000 years ago.

Perhaps there is reason in all this, even 400,000 years may have been needed to give man time to overrun the whole earth, to sample all the numerous kinds of grass seeds and grass eating animals as the first necessary step in choosing the few best suited to provide food for his growing family. Further, it was so ordered by nature, that man could learn by absorbing the knowledge and experience of numerous generations and countless individuals that in the end large populations could be maintained and directed as teams to achieve still larger ends. It may well be that 400,000 years of conditioning was none too long.

THE SPREAD OF WHEAT CULTIVATION is indicated by the following approximate dates: valley of the Nile 5000 B. C.; Euphrates and Indus, 4000 B. C.; China, 2500 B. C., and England 2000 B. C. Further, the use of the cart, plow, and bronze spread over about the same area between 3500 and 400 B. C. Since these are important traits in ancient civilization, we can say that the area for wheat is also the area of ancient civilization. Note again that China and England are marginal and that the elements of civilization reached them last, diffused from the ancient centers of Egypt, Sumer, and India

After Carl Whiting Bishop, Annual Report of the Smithsonian Institution, 1940

EARLIEST CENTERS OF CIVILIZATION as defined by the ruined cities of On, Ur, and Mohenjo-Daro, the best known early sites. Further explorations may lead to new discoveries and some changes in the picture

Wheat

WHEN man developed the idea of sowing a grass seed and protecting the growing plant until gathering or harvesting time, it naturally followed that he would save some of the seed for the next planting time. The natural thing to do would be to select the best seeds for each planting and in this way the yield would be increased, but botanists remind us that there are other considerations. Wild plants are adapted to survive independent of man, hence they possess structural patterns which loosen the mature seeds so that they will shatter out of their hulls, easily fall to the ground, or are anchored to parachute-like devices which enables the wind to carry them abroad. A familiar example of the latter is the dandelion. Yet since man expects to harvest the seeds he sows, he must needs change the nature of the plants, that the seeds cling to their hulls and the hulls to the stalks, until man shakes them vigorously or beats them out. This is carried to such an end that many domestic seed plants are unable to reproduce unless man saves some seed and plants it at the right time of the year. There may be many other factors involved here but it is clear that neither wheat, barley nor corn are capable of surviving independently in a wild state, but are even more dependent upon man than are many of the domestic animals.

Although obviously derived from wild plants it is extremely difficult to identify the wild ancestors of wheat, barley, etc. When man began to farm he attempted to destroy the wild grasses to make room for his favorite crops. Further, he carried his seeds abroad, planting them where their wild ancestors were unknown. This coupled with the changes the selection of seeds has brought about in the cultivated forms, increases the difficulty of identifying the original plant. Plants, especially the grasses, seem prone to mix or cross with wild species, thus further complicating the problem. So we need not be surprised that the ancestors of wheat are still somewhat uncertain.

Again it is equally difficult to find the place and the time when the first plant was domesticated. What we certainly know is that most of the cereals were planted before writing was sufficiently advanced to record events, or more than 6000 years ago. Further we can be relatively certain that the first civilizations to come of age were among the wheat eaters. (Map. p. 5.)

ARCHAEOLOGY tells us that civilization first emerged on the edges of three widely separated mud flats at the mouths of as many rivers, or around the deltas of the Nile, the Euphrates, and the Indus. Each of these rivers runs the main part of its course through an arid terrain, the world's greatest stretch of desert lands. Westward from the Nile lie 2,500 miles of the Sahara; eastward, between

the Nile and the Red Sea is a long narrow desert; between the Red Sea and the Euphrates lies the great Arabian desert; between the Euphrates and the Indus lie the semiarid and desert lands of Iran and Baluchistan; immediately east of the Indus is the Indian desert. Though little rain ever falls on the lower courses of these three rivers, their upper branches traverse areas where heavy rains are periodical, causing annual floods in the deltas.

One would least expect to find the dawn of civilization in such a setting, yet on the edges of these deltas we find the ruins of predynastic Egypt, of Sumer, and of ancient India. Here emerged the first planned cities the world ever knew, such as On (Heliopolis), Ur, and Mohenjo-Daro, all flourishing about 4000 B. C.

Until recently Egypt was believed the oldest and so the mother of civilization, but archaeological research in Sumer around the year 1926 revealed cities of a more advanced type than in the Egypt of 4000 B. C. Then a few years later cities on the Indus were uncovered which threaten to contest the lead of Sumer. Expert opinion, however, tends to concede a slight lead in priority to Sumer. Yet archaeology goes further in giving satisfactory proof that Sumer and her successors along the Euphrates passed on to Europe much of the "glory that was Greece" and so can justly claim to be the "mother of Euro-American civilization."

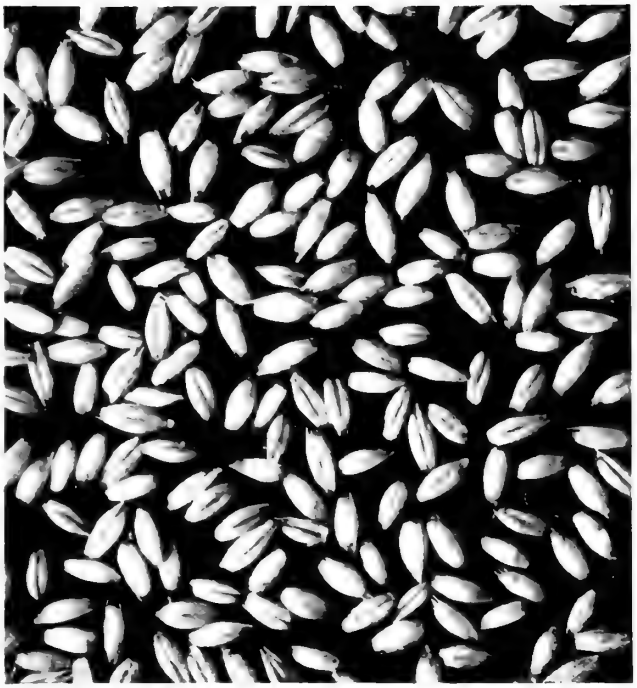
There is little reason to suspect that these three centers of civilization developed independently, since they are not only contemporaneous but when looked at closely their respective ways of living follow a common fundamental pattern. The most conspicuous common element in this pattern is the use of wheat. Between the mere sowing of wheat grains and the consumption of bread derived from it is a complex of skills and processes, the details of which would fill a large book. However, we now present a brief and simple handbook recounting some of the most important incidents in the story of the food grains and the evolution of civilization.

The general pattern of this civilization may be characterized by cereals, domestic animals, the plow, the wheel, metals, writing, calendars, and cities. It is difficult to realize that these were then unique, novel traits of culture, appearing in the world for the first time. And what is more they are still the fundamentals of civilization.

Again archaeology tells us that man had existed for several hundred thousand years before civilization happened. In the meantime he had overrun the entire world, but his numbers were limited by the amounts of wild foods available and his ability to seize them.

In contrast civilization arose some ten thousand years ago and was scarcely under way before 4000 B. C. What amazing changes has mankind experienced during these last 6000 years! But even more astonishing is it that between 7000 and 4000 B. C. were made all the basic inventions underlying our civilization. Nothing so revolutionary happened before or since.

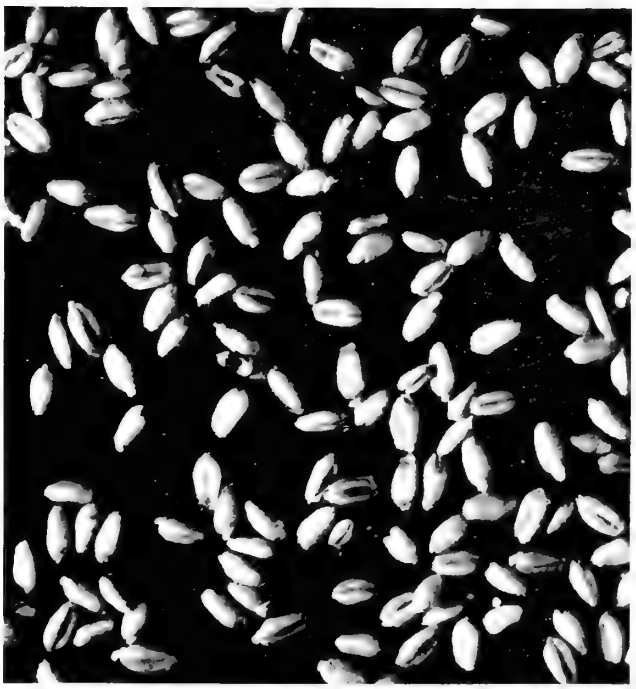
The change in the way of living which set off this burst of inventive genius was the discovery of agriculture and the domestication of animals. We speak of this as revolutionary because it was a radical step. Throughout the long stretch of Old Stone Age time man simply gathered his food when and where nature made it available. For ages man was blind to his opportunities. Instead of pursuing and killing game animals, thus making them scarce and wild, he could have lived in friendly co-operation with them, protecting and conserving them, and living in luxury on their increase by the simple device of saving females and sacrificing the males. His native intelligence would soon reveal to him the principle of improvement by selective breeding. Within a generation or two he could have come into control of his animal food supply, instead of being dependent upon what nature offered him. All this seems so obvious to us that we are moved to lament the stupidity of man during 400,000 years



WHEAT

RYE

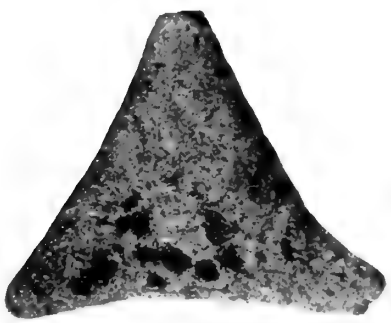
OATS



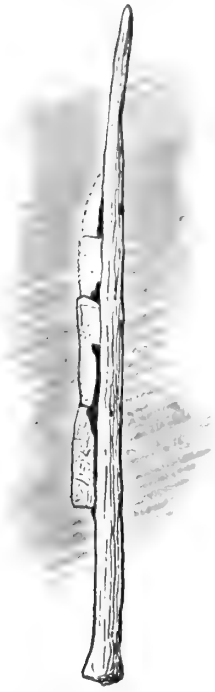
BARLEY

EARLIEST KNOWN BREAD

At the ancient Egyptian site of Deir el Bahri the elements of civilization appear associated with wheat and barley. Strange as it may seem, some loaves of bread survived owing to the dry climate. A magnifying glass shows barley to have furnished at least part of the flour. Age estimated at 3500 to 4000 years



Courtesy of The Metropolitan Museum of Art



A STRAIGHT SICKLE made of flint blades set in bone. Length, 20 inches. From Neolithic Period, Fayum, Egypt. (Adapted from *Antiquity*)

of the Old Stone Age.

Yet the less obvious was to discover what could be done with the seeds of wild grasses. We now know that the most concentrated form in which nature supplies food is in seeds, but again it took man about 400,000 years to realize the significance of seeds—to see that in the application of his particular brand of intelligence to the exploitation of seeds lay the key to his future. We may never know just when and where some primitive genius first achieved insight as to how seeds could be multiplied and improved, but we do know that with the raising of wheat in the region of the three great river deltas the first civilizations emerged.

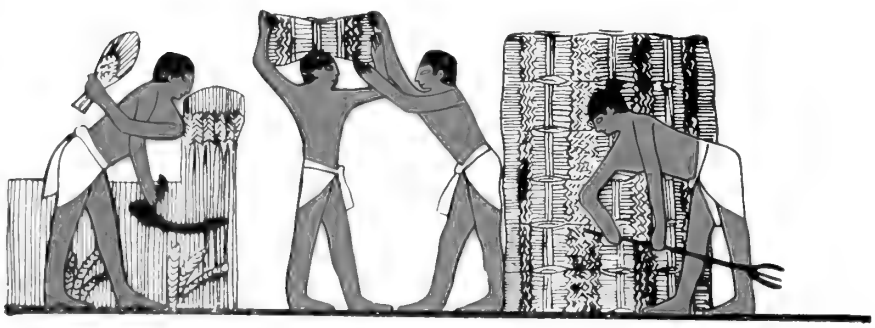
We gave the cereals first place in the fundamental characteristics of civilization because that is the verdict of history. The data from archaeology reveal that wheat, barley, and millet are the cereals which appear first. Later emerge rye, oats, and rice, all originally wild grasses. From the earliest known graves in the delta of Egypt come seeds of wheat and barley. In the delta of the Euphrates millet seems slightly earlier than wheat and barley; in the Indus valley, wheat appears with barley.

Everywhere wheat was preferred as it is still. It is abundant in yield, can be readily stored, preserved for a long time, and easily transported. Wild wheat (emmer) and barley survive in a few localities, ranging from Mount Hermon in Palestine eastward into central Iran both found growing together as man probably noticed them before he began to cultivate them.

NOW that we have taken note of the evidence that mankind after a long period of preparation rather suddenly domesticated plants and animals; that among these the cereals and a few food animals furnished the main foundation stones for our civilization; that wheat must be recognized as the cereal No. 1; we can turn to the important details of wheat culture.

Wheat Farming

Under the most conceivably primitive conditions wheat was sown broadcast to cover the ground thickly enough to discourage weeds and other grasses from intruding. No cultivation was attempted, but grazing animals must have been kept away and stray weeds and grasses pulled out by hand. Apparently man learned by accident that the best way to clear the ground for wheat was to burn over the surface before planting, thus not only destroying the old plant cover but killing the seeds of all the wild plants. Next the surface of the soil was broken up and after the grains of wheat were broadcast by hand, brush was dragged over the surface to cover up the grains, lest birds eat the most of them. In ancient Egypt, and no doubt in the low lands of the Euphrates and the Indus as



HARVEST TIME in Ancient Egypt. A laborer cuts the grain with a sickle. Others heap the bound grain before the threshing floor. (Adapted from *Mummies* by Richard A. Martin, Chicago Natural History Museum Publication)

A BONE HANDLE of a sickle from which the blades have been lost. Length, 15 inches. From Palestine. (Adapted from *Antiquity*)

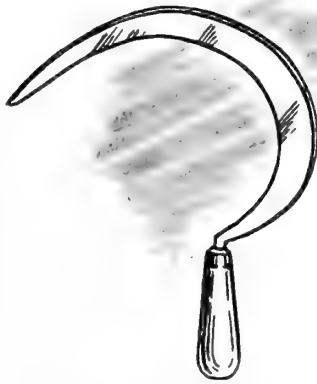
A LATER TYPE of flint sickle with a curved cutting edge. From Egypt. (Adapted from *Antiquity*)

A BRONZE SICKLE of about 600 B.C. From Denmark. (Adapted from *Antiquity*)

well, wheat was sown on land flooded by seasonal rains at the headwaters of the respective rivers, before the new layer of mud spread by the water was dry; then sheep and even cattle were driven over the field, back and forth, to trample the seed into the ground.

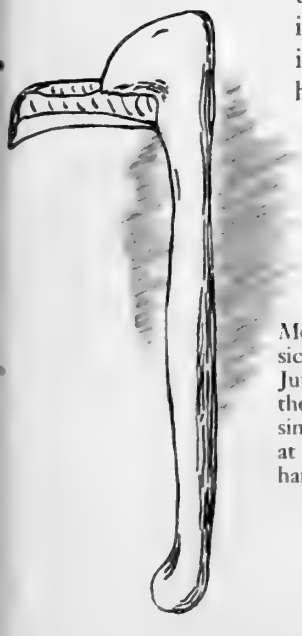
When the grains of wheat were mature, or the straw turned yellow, it was time for the harvest. Men and women began at one side of the field to cut the stalks with knives, tying the straw into bundles with the heads always at the same end. No doubt a simple knife was the first to be used. The oldest knives especially devised for this purpose, were of stone; first a straight piece of wood or bone into which small flakes of stone were fastened, giving a saw-like edge. In ancient Egypt this soon evolved into a hooked stick and finally into the familiar curved tool we know as the sickle. In the bronze age sickles were made of bronze and later of steel. We still use a similar tool for cutting grass and weeds. The author remembers that steel sickles were still used in his community for harvesting wheat beaten down by heavy rains. Strange to say these sickles had cutting edges grooved on one side like files, thus giving a saw-like edge, possibly reminiscent of the ancient sickles with rows of tiny flint flakes.

After the harvest the bundles of wheat stalks were carried to a threshing floor, at first merely a smooth patch of ground, tamped down hard, upon which the grains of wheat were trampled under foot or beaten with sticks. Even in very ancient times cattle were often driven back and forth over the grain to trample out the seeds of wheat.

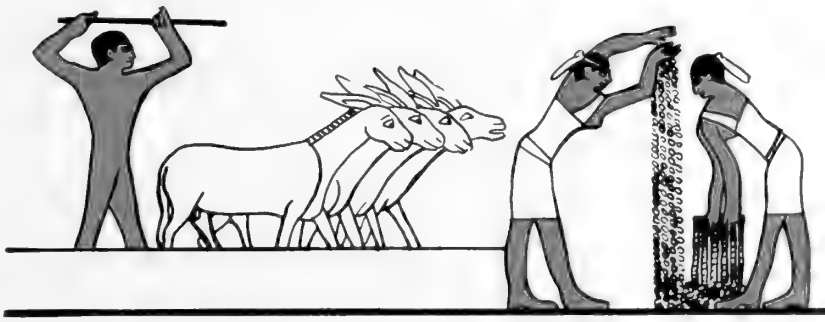


A MODERN steel sickle, with a wooden handle

The straw was then removed with a forked stick or a crude rake, leaving the seeds mixed with hulls or chaff. Removing the chaff is called winnowing, because the procedure was to toss a mass of chaff and grain into the air; even a light breeze is sufficient to deflect the lighter chaff aside from where the grain falls. The clean grain was then gathered up in baskets or bags for carrying to storage places.



MODEL of the Stenild sickle, found at Stenild in Jutland, and dating from the Bronze Age. Here a single flint blade is set at right angles to the handle. (Adapted from *Antiquity*)



HARVEST TIME in Ancient Egypt. Donkeys tread out the kernels on the threshing floor. Two women work at winnowing the grain. Drawings from a carving in an Egyptian tomb. About 2400 B.C. (Adapted from *Mummies* by Richard A. Martin Chicago Natural History Museum Publication)

The Plow

For several thousand years there was little change in these methods, nor has the order of these processes ever changed, but within the past two hundred years many mechanical inventions and shifts from animal to steam and tractor power can be noted. One of the oldest inventions was the plow, still of primary importance.

The old theory was that the plow developed from the hoe, but now that we have more data on the early forms of the plow, it is clear that it evolved from the digging stick, a stick pushed into the ground to break up the soil. Possibly the first plow was drawn by men as shown in an Egyptian wall picture, but in other Egyptian drawings oxen and even donkeys are yoked to the plow. In one of the Egyptian drawings the grain seems to be thrown so that the plow will cover it, but a sketch on a seal from Babylon goes a step further in showing a seeding machine, the seed being dropped into a funnel which discharges it behind the point of the plow. This is a near parallel to a modern type of machine for sowing wheat.

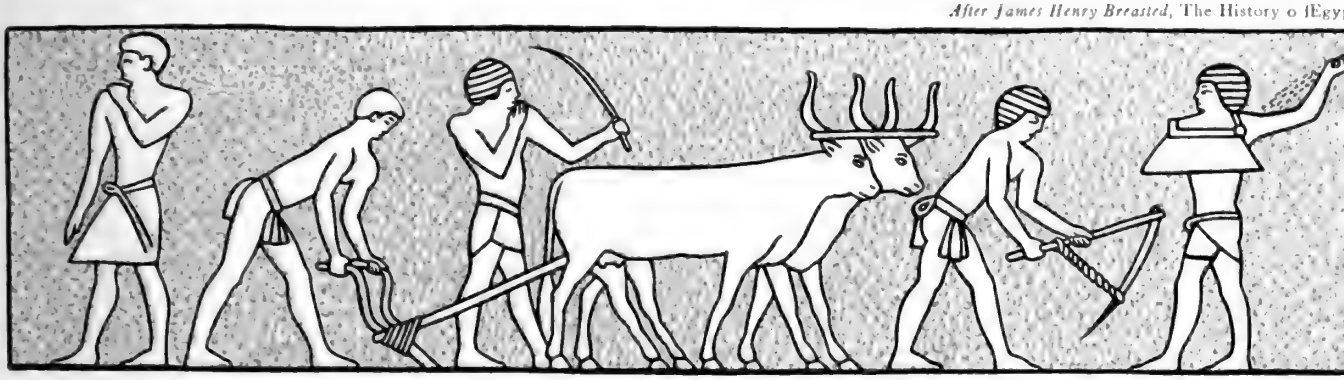
These ancient plows seem crude and simple, yet the type survived until recent times. Around 1550 the Spanish introduced the plow and oxen into Mexico and thence to the Indians. As late as 1900 Pima and Papago Indians were using crude wooden plows in Arizona and northern Mexico, examples of which are in the collections of the American Museum of Natural History. Some of these were provided with stone points, indicating that the stone age still lingered here. The plow of today, the modern mould-board plow, was invented by Thomas Jefferson, about 1800.

PERUVIANS PLANTING POTATOES

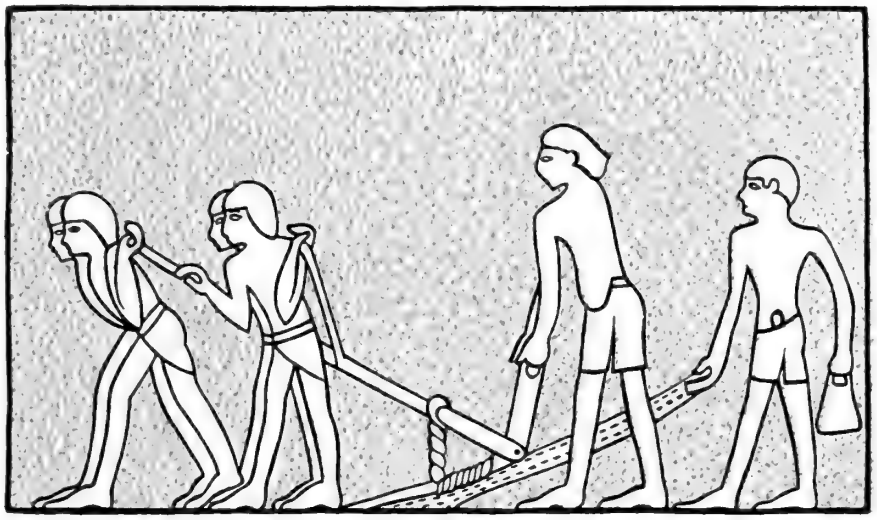
THE ABORIGINAL FOOT-PLOW was an improved digging stick used to turn sod and hard ground. Simple forms of the foot or digging-stick plow were used in western Europe within the last century

Courtesy of the Chicago Natural History Museum

After James Henry Breasted, The History o fEgy

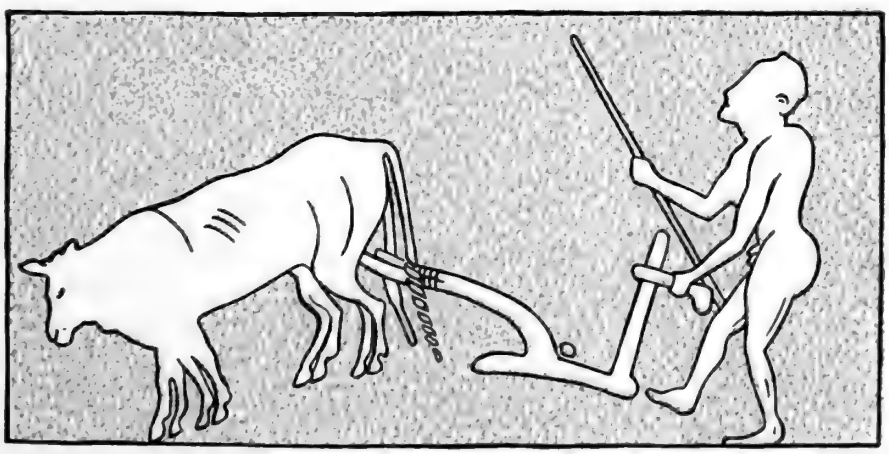


EGYPTIAN PLOW drawn by cows. Note the two handles. It has been proposed that the Egyptian hoe, as shown at right, was the original form of the plow. But the simple digging stick and its successor the foot-plow are now considered the probable parental forms



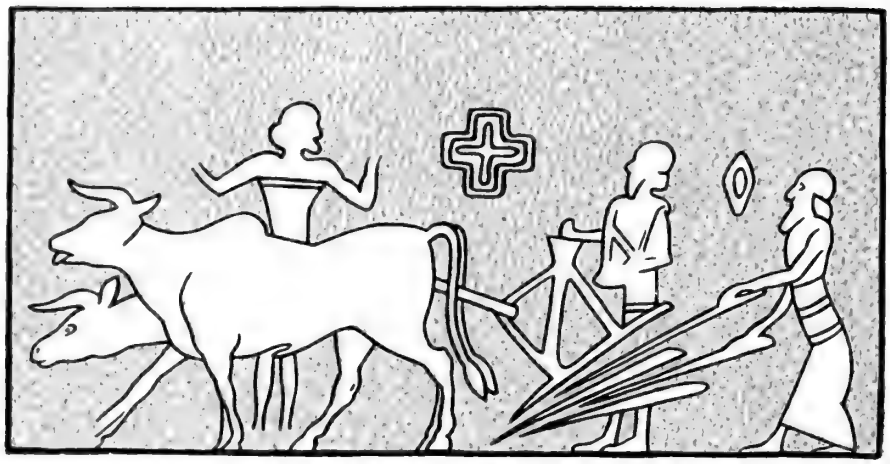
AN EGYPTIAN man-drawn plow. Grain is sown by casting into the furrow. 18th Dynasty, about 1400 B. C.

After Carl Whiting Bishop, Ann. Rept. Smithsonian Institution, 1937



EARLY GREEK PLOW, from a vase painting. All these ancient plows used cattle, not horses. The horse appears relatively late in ancient civilization and was at first valued for its speed and use in war

After Carl Whiting Bishop, Ann. Rept. Smithsonian Institution, 1937



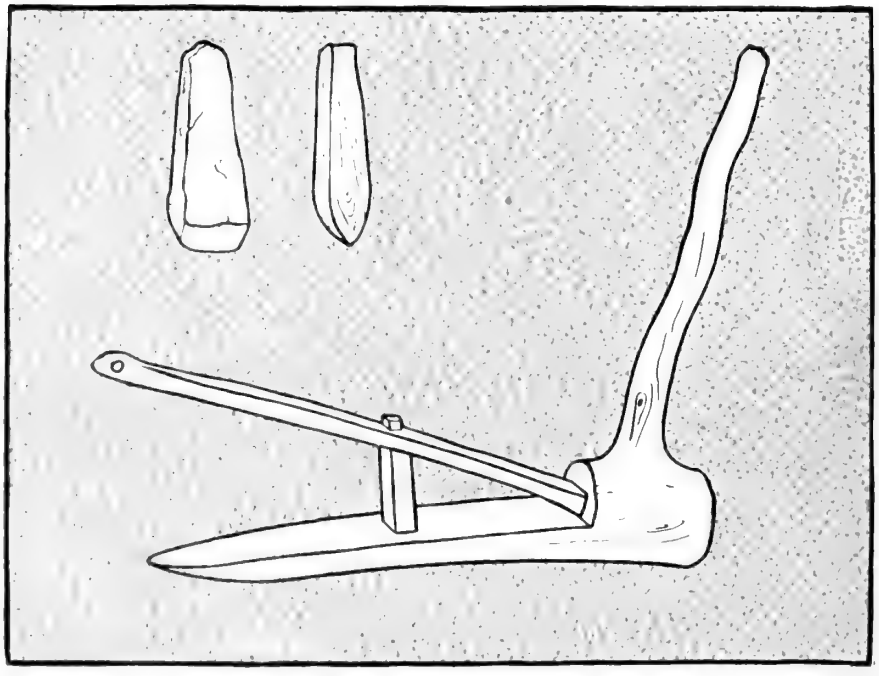
EARLIEST KNOWN MECHANICAL SEEDER. An ancient seal from the Euphrates country shows this plow equipped with a hopper to receive and sow the seed

Courtesy of the Univ. of Penna. Museum Journal, 1910

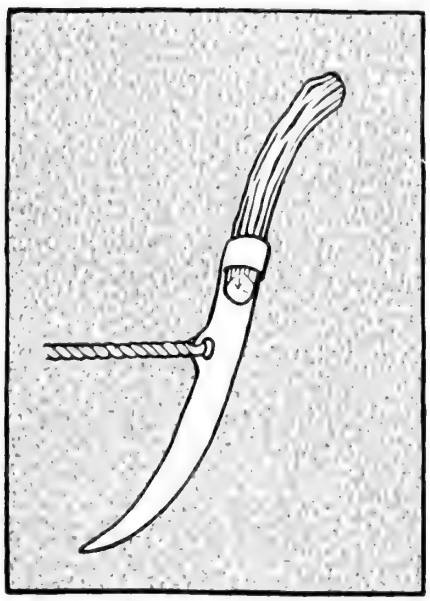
Harvesting Machines

Harvesting machines are for the most part less than a century old. As stated the oldest device was the sickle. In the British Colonies in America the first radical invention was the "cradle," a scythe with a frame-work attached to pay out the stalks evenly behind the mower, whence they could be easily gathered into bundles for tieing. Much later in the United States a reaper was devised, a machine drawn by horses or oxen, which cut a wide lane through the standing grain, dropping it in orderly fashion upon the ground. Later improvements bunched the wheat, dropping these bunches off ready to tie and still later devices gathered the wheat into an orderly bundle, tied it with twine and threw it upon the ground. Finally, an Australian is credited with combining a threshing device with a reaper which delivered the grain free from chaff as it was drawn along, now known as a "combine."

In the meantime threshing devices had passed through an independent evolution, the oldest invention was the flail, a simple two part club for beating the wheat by hand. Yet until the last century the universal method was to tread out the grain with horses or oxen. Then a machine with a toothed cylinder was invented, driven by a horse power tread-mill, quickly elaborated by adding a winnowing attachment using a rotary fan. Later a portable steam engine was used to supply the power, at first pulled about by horses or oxen, but later geared to draw itself



A SURVIVAL of the primitive plow is found among the Indians in Arizona and Mexico. As late as 1850, some of these plows were used with detachable wooden or even stone points



JAPANESE ceremonial plow in the form of a digging stick with an iron blade, drawn by man-power. From a drawing by the author; specimen in the museum of Tokyo

and the threshing machine by its own steam power. This preceded the automobile, finally to be replaced by the tractor.

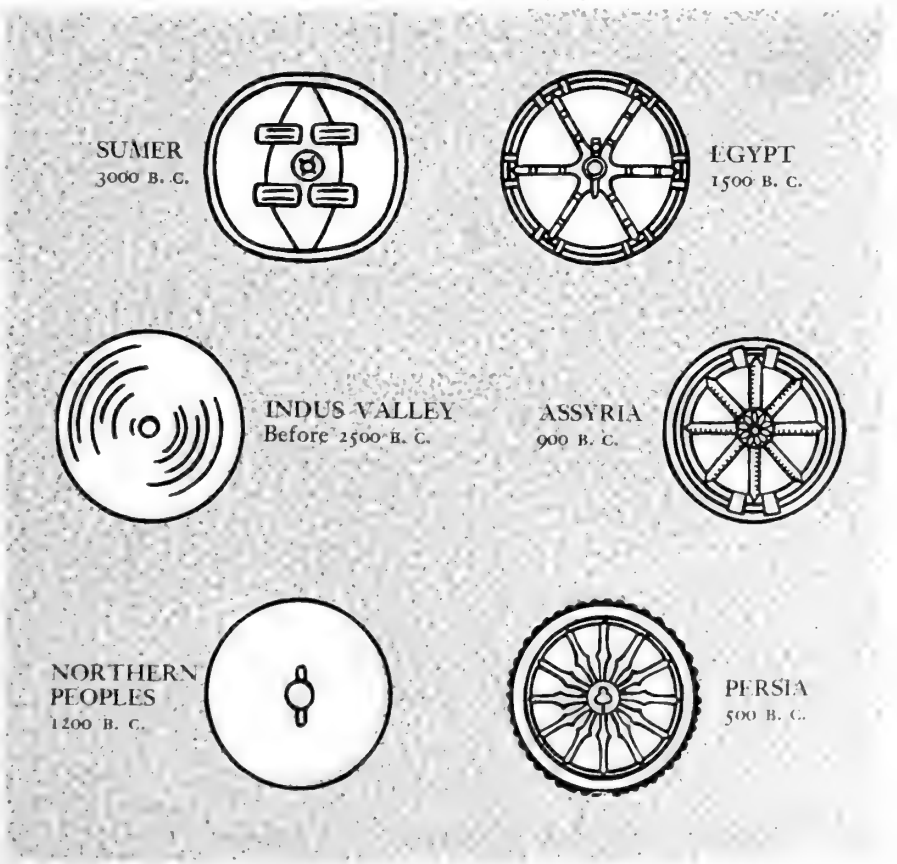
The winnowing process was mechanized first by a "fanning mill," operated by a crank which facilitated the winnowing, universally used in days when animals trod out the grain. Historians tell us that the "fanning mill" was invented by the Chinese several centuries before it appeared in Europe. Since pictures in ancient Chinese books are duplicates of European models, the whole device was no doubt copied from these people. The threshing machine and the combine merely incorporated the "fanning mill" into those devices.

Flour

Practically all the wheat eaten by man is in the form of bread made with flour. In primitive times wheat was treated like wild seeds, crushed between stones or in a mortar.

Yet since the ancient Old World civilizations understood the wheel, they soon devised the rotating mill or *querm.* At first this device was turned by hand as shown in the illustration, a device still used in many parts of the Old World. Eventually this device was mechanized, by applying water-power, wind-power, horse-power, steam, gasoline and electricity. Even in power mills, stone

After James Henry Breasted, Ancient Times



THE PLACE AND TIME for the origin of the wheel are obscure. Its distribution over the ancient world closely followed the ox and the donkey

discs were universal until about a century ago, when metal rollers were introduced, now almost universal, though here and there, even in the United States, water power mills with grinding stones are still in operation.

For a long time flour making was a household operation, the coarse parts of the wheat being sifted out of the flour by hand. Now a flour mill is a complicated factory, in which bran, shorts, middlings, etc. are separated from the residual white flour, and used for stock food.

The Wheel and the Cart

Since the wheel and the cart have played such a large role in the evolution of Old World civilizations, some note of them seems in place. Historians usually regard the wheel and the plow as among the few traits best characterizing the pattern of Old World civilizations.

If you wish to evaluate the wheel as a trait of civilization, try to imagine what would be left if the principle of rotation were completely blotted out. Power-driven transportation would disappear. Away would go windmills, water wheels, steam and electric power. All goods must then be carried on the backs of men and animals, in rowboats or in small sailing vessels. Even hand- and foot-driven machinery would be eliminated. We cannot conceive of a worthwhile world entirely ignorant of the wheel. The earliest known wheeled vehicles appear in Sumer, four wheelers drawn by donkeys. A little later we meet with the chariot, or cart, first drawn by donkeys, then by horses. Ox-drawn carts, also, are shown in ancient drawings and sculpture.

Domestic Animals

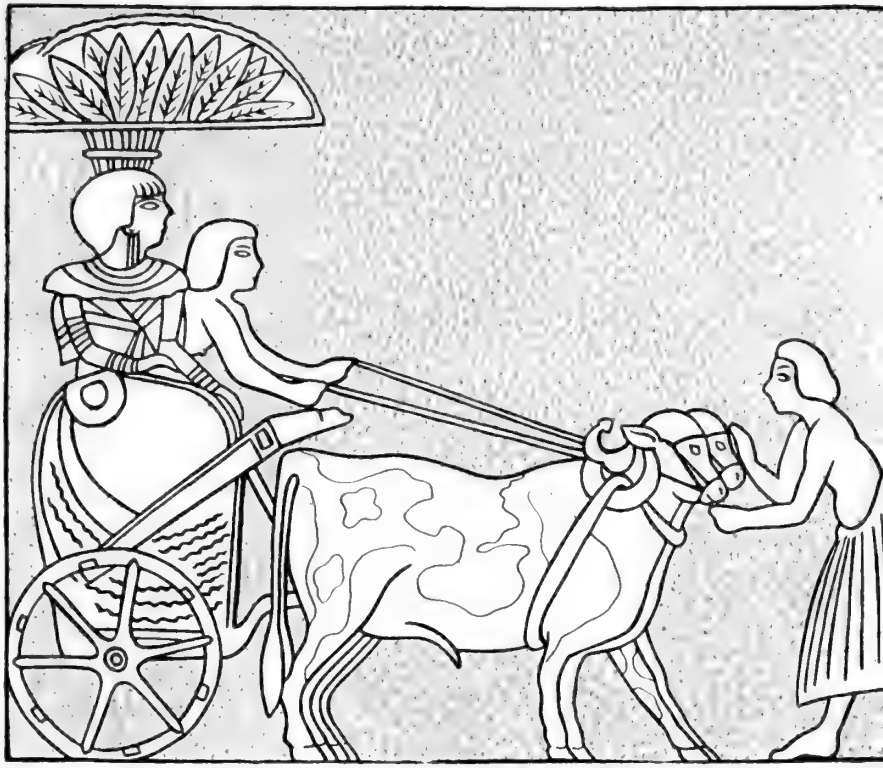
In equal measure the evolution of animal husbandry is pertinent. Not only are the ancient cereals still of vital importance, but the leading food animals—cattle, sheep, goats, and swine—are still the best. Their bones appear in the remains of these first civilizations, and there is abundant evidence of their early domestication in surviving sculptures and frescoes on the walls of temples and tombs. Aside from the ox, the first draft animal to appear is the donkey; the horse appears some 1,000 years later, and the camel still later.

We find early sculptures and wall paintings showing the milking of cows in stables. Many such pictures found in Egypt appear modern in that the hind legs of the cow are tied to prevent her kicking the milker, and the calf is kept in front of the cow to check any tendency to "hold up her milk," a trick still used by our farmers. There are lifelike scenes of cattle being driven and led from pasture to stable. In one instance a man walks in front of the cow with her new-born calf on his shoulders, a sure way to induce her to follow.

The wild ancestors of cattle, sheep, goats, swine, and the donkey seem to have lived in and immediately around the three great centers in which these ancient civilizations emerged. Hunting scenes in which wild bulls, boars, and donkeys are pursued furnish evidence that the wild species were not immediately exterminated by domestication. We suppose it was an accident of nature that the wild ancestors of the best domesticated seed grains, food and draft animals evolved in the same part of the world.

The History of Bread

However, the most significant part of the story of wheat remains to be told. Somewhere within the area shown in our map (p. 5) some baker of wheat bread discovered yeast and raised bread. Either writing was unknown or in its infancy at the time or the discovery may have seemed too trivial to record. Many modern writers suspect the discovery was made in Egypt. The Jews seemed to have learned the art from abroad since they found it necessary to bar the use of yeast bread in traditional religious rites.

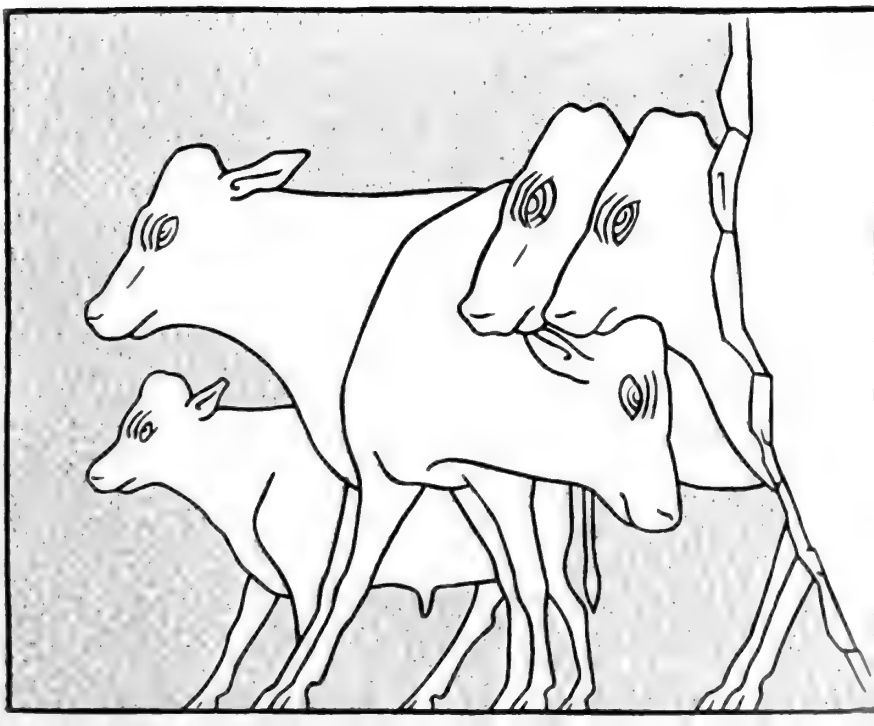


THE OX was sometimes used with a chariot in Egypt, as shown by this wall picture. The passenger is appropriately a woman. The men drove horses

Courtesy of The Metropolitan Museum of Art

THE EARLIEST portrayed war chariot had four wheels and was drawn by donkeys. Sumer, about 3000 B. C.

Courtesy of The Library of Science and Culture



SKULLS exist proving Egyptians bred both hornless and long-horned cattle, suggesting a long period of skillful breeding. 29th century B. C.

After James Henry Breasted, The Scientific Monthly

Naturally such new-style baking would profane all sacred rites and so be sacriligious. The mixing of yeast dough with fresh wheat flour starts a ferment which causes the dough to rise and become porous, or "light." When baked the heat kills the yeast and so stops fermentation, giving a light soft spongy bread. Wheat flour happens to be the only cereal producing successful "light" bread because it contains the proper amount of gluten to hold the gas bubbles resulting from fermentation. Rye seems to approach the standard but needs the addition of some wheat flour to make passable bread. So from that time to this man has preferred wheat bread thereby rating wheat the leading grain food.

There is an interesting book, "Six Thousand Years of Bread" from which we quote the following:

"Long ago Occidental man acquired a definite preference for raised bread instead of cooked cereals and flat breads. Bread reigned over the ancient world; no food before or after exerted such mastery over men. The Egyptians who invented it, based their entire administrative system upon it; the Jews made bread the starting point of their religious and social laws. The Greeks created profound and solemn legends for their Bread Church of Eleusis, and the Romans converted bread into a political factor. They ruled by it, conquered the entire world by it, and lost the world again through it. At last the day came when Jesus Christ made consumate all the spiritual significance that had become attached to it, saying:

"Eat! I am the bread." *

It is a long road from the indiscriminate gathering of wild grass seeds to yeast bread, but it was a glory road. Nothing seems to dwarf its greatness. Though what we know of its historic background is vague, it is logical. The reality is obvious and undeniable. The long and persistent survival of yeast bread is sufficient proof of its usefulness. Rice is still preferred boiled. Maize gives corn meal and corn bread, good food only when wheat bread is not available. Some imaginative people assert that it is the possession of true bread and, of course, wheat, which accounts for European culture dominating the world, but this is probably a case of "the cart before the horse." However, the superiority of wheat bread may well account for the cultivation of wheat wherever possible.

The most ancient civilizations of the Old World seem to have evolved among the wheat growers. Closely trailing them were the rice growers and next the maize growers of the Western World. There is reason to suspect that for a long time the evolution of each of the three great cereal areas (Map p. 17) was independent. The first to come in contact were wheat and rice civilizations; much later wheat using peoples found their way to the Americas, whence corn (maize) came to their knowledge, about 1500 A. D.

Archaeological data shows that the use of wheat is older than the use of rye. Rye, however, will grow in climates and soils unfavorable to wheat, but makes inferior bread. In time the superior bread making quality of wheat led to the evolution of wheats which would grow in colder climates, thus widely extending the wheat area and restricting the use of rye.

Rice

The second great cereal area centers in southeastern Asia and the adjacent island world, the motherland of rice eating civilizations. In contrast to wheat, rice originated in a tropical, rainy, marshy country. The cultivation of each spread abroad rapidly about as far as its growing habits permitted.

The area devoted to the cultivation of rice is evidence of its importance to man. The number of people who depend upon it for food is even more impressive. Almost every-

* Six thousand Years of Bread. H. E. Jacob. p. 17.

where in Southeast Asia, rice ranks as the main food. Because of the density of population in that part of the world, it is estimated that one half of the human race lives upon rice. The other half of the world's people occupy a much greater area, but for the most part they are bread eaters (wheat, barley, rye, and corn).

When we think of rice, we think of China, but in India rice plays an even larger role. British India alone, with a population of about 300 million, produces annually about 600 million bushels of rice. We have no good statistics for China with its 400 million people, but it is estimated that she produces less rice than India. Hence, it would be a mistake to rate China as a whole as being fully dependent upon rice, though rice is the chief food in the southern provinces.

In a region like the Philippines, native life is largely organized around the production of rice. Its importance is shown by the special rituals that accompany almost every phase of its cultivation and processing. It is the only food recognized by such ceremonies in the Philippines. As A. L. Kroeber expresses it in his well-known book,* "The native point of view is clearly that if the success of the rice is assured by the necessary magical and ceremonial means, other crops will automatically take care of themselves. When plant food is offered to the spirits in any connection, it is almost invariably rice. In short, the Filipino not only eats rice, but thinks in terms of rice, and if his civilization is to be described in a

* *The Peoples of the Philippines*, page 86. (Handbook 8, The American Museum of Natural History.)

The Three Great Cereal Areas of the World in 1500 A. D.

single phrase it can only be termed a rice culture."

We have noted that there is still some difficulty in identifying the wild ancestors of wheat and corn, but cultivated rice seems definitely to have come from a single species, *Oryza sativa*, native to the East Indies. All rices grown are regarded as varieties of this species, and they are surprisingly numerous. According to some writers, about a thousand varieties of cultivated rice are known in India alone, all of which are special strains, adapted to local differences in soil, temperature, and rainfall. In the main, however, a tropical or at least a subtropical climate is required. The plants are annuals and reach a height of two to five feet, with panicles (seed heads) roughly resembling oats.

The original wild species required low ground that was flooded at least part of the year. The cultivated varieties known as "hill," "upland," or "dryland" rice can be nursed through the growing season without flooding, but the yield is less and the grains smaller than in the aquatic varieties.

Rice Farming

One of the regions often chosen to best exemplify aquatic rice-growing is the Malabar coast of southwest India. This coast receives torrential rains in May, June, and July, followed by a period of moderately heavy rains in October. The dry season is from December to March. The lowlands of the coastal belt vary from 30 to 50 miles wide and are thickly populated by rice-growers. There are 1000 to 2000 inhabitants to the square mile. Originally these lowlands were covered with dense deciduous forests, which were later cleared for rice growing. All the land that can be flooded by impounding rainfall and river water is devoted to rice. Sixty to 120 days are required for a crop, depending upon local conditions. Harvest time is usually in September.

Before the rains begin, a simple pointed plow is used to scratch up the surface of the ground. Water buffaloes are preferred to oxen and are yoked to the plow either singly or in pairs. Cattle dung is spread over the

CULTIVATED RICE in the field *Photo from U.S. Dept. of Agriculture*

CULTIVATION OF RICE apparently came later in history than wheat. But wild rice was probably eaten in the East Indies long before the plant was domesticated. The only implements the first rice-growers used seem to have been digging sticks and wooden spades. Only after the cultivation of rice spread to the Asiatic mainland and contact was made with people who grew wheat and millet were the plow and draft animals adopted. "Dryland" rice, as distinct from that grown in flooded fields, was probably developed through watching wheat farmers at work

Photo by Lionel Green, from Frederic Lewis

plowed surface, which after the first rains is plowed once more, and the earth is finally smoothed by dragging a log back and forth.

When all is ready, the banks, or dikes, surrounding the field (paddy) are repaired. If the timing has been correct, the rains now begin, and as soon as the ground softens up, the rice seed is sown broadcast, sometimes trampled into the mud, sometimes not. The plants begin to grow in the water-covered soil. At intervals during the growing season, men and women wade into the rice paddy to pull out the intruding weeds. Finally, the water is drained from the paddy to permit the ground to harden. When the rice is mature, the heads are cut from the stalks with various kinds of knives or sickles. Immediately thereafter, millet, pulse, or sesame is sown. Water buffaloes, a few cattle, and sheep and goats are herded upon the wastelands and are fed in part upon rice straw, chaff, and other crop foods, such as millet, oil cake, etc.

Turning from the Malabar coast-dwellers to Asiatic and insular rice-growers in general, we find that wherever the growing period is short, rice may be sprouted and grown for a time in flooded beds and then transplanted by hand to flooded rice fields. This naturally adds to the labor of rice production.

When the rice grains begin to mature, the fields are raided by seed-eating birds, often in such numbers as to leave but a small harvest. A common method of keeping the birds away is to stretch a number of strings across each paddy, with streamers or pennants attached to them. These flap about when the cord to which they are fastened is jerked vigorously. Small platforms or towers are erected so as to enable a single watcher to guard four plots. This is no small task, because the flock, when disturbed, merely takes wing to descend at another location.

Processing the Crop

Threshing rice involves two operations. As in oats, a hull or husk firmly encloses each grain, and this must be removed by rubbing or gently beating the grain in a mortar or upon a mat. The most primitive way is to tread barefoot upon the unhulled grain.

The next step is to separate the detached hulls, or chaff, from the grain by winnowing. The usual way is to scoop the trampled mass into a shallow basket and toss it into the air above a mat or sheet. The heavy grain falls straight down, while the chaff is floated to one side by the gentlest of air currents.

For the most part the hulled grains of rice are not white but are covered with a coat of brown, which can be removed by rubbing or beating, a process called "polishing." However, many native rice-growers dispense with this procedure and eat "brown rice" instead. The food value of rice is decreased by polishing, yet custom regards white rice as preferable.

TRANSPLANTING RICE. Sometimes the seed is sown broadcast, sometimes it is trampled into the mud. Here the young plants are being replanted, near Baguio in the Philippine Islands

A.M.N.H. photo

MULTIPLE SCARECROW: an arrangement of lines extending to all portions of the field and jerked as needed from a central tower. This device is used frequently in Hawaii. Constant vigilance is necessary to save the rice crop from birds

Seeda Studio photo

WHEN the field is dry and the rice mature, knives or sickles are used to harvest it. A scene in Bali

Photo by Lionel Green, from Frederic Lewis

A Japanese rice garden

Three Lions photo

In the Philippines, as in many other parts of the rice area, hillsides are utilized by the construction of terraces, or walled-in shelves, extending horizontally one above the other. These are flooded with water in the rainy season. The magnitude of these terraces, covering the landscape from valley to hilltop like a gigantic series of hanging gardens, is impressive. The prodigious task of keeping them in order means that the owners make rice-growing their chief concern. Hand labor prevails, with the simplest mechanical appliances,—little more than digging sticks, crude wooden shovels, and the bare hands. The plow, first developed by wheat farmers, seems to have been introduced by the Spanish conquerors of the Islands.

Since 1500 A. D. the cultivation of rice has been introduced into many tropical and semi-tropical areas, such as southern Europe and North Africa, and parts of west Africa,

Heavy wooden pestles are sometimes used in hulling rice in the Philippines

Theodore Roosevelt, Jr. Collection, A.M.N.H.

Treading rice in the Philippines: the aboriginal method of threshing the world's staple food grains

Fenno Jacobs photo, from Three Lions

After the rice is hulled, it must be winnowed. The kernels fall to earth and the chaff floats away

Alfred T. Palmer photo, from Black Star

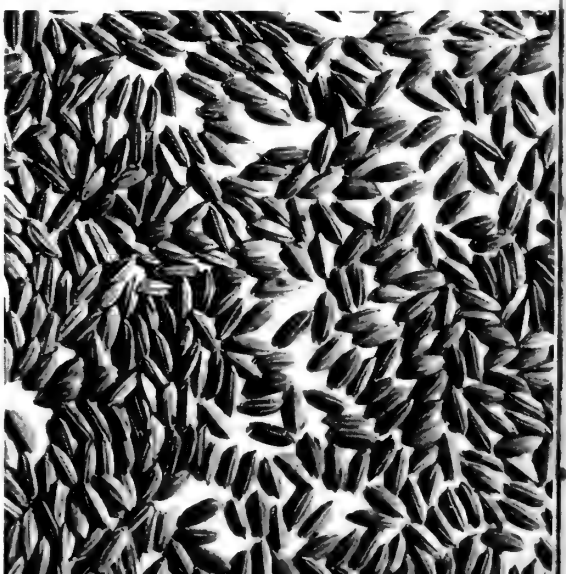
Fenno Jacobs, from Three Lions

BEATING RICE to separate the kernels from the husks, in the Philippines

THIS VIEW in a Chinese shop in the town of Pishan shows a method of hulling rice that has been in use for centuries

Alexanderson (C N S), from Gvillumette, Inc.

UNHULLED RICE KERNELS



THE LABOR OF TENDING HILLSIDE RICE TERRACES like these and of keeping the dikes in repair can easily be imagined: a scene in Ifugao Subprovince, Luzon, in the Philippines, where human life revolves about the growing of rice

Theodore Roosevelt, Jr. Collection, A. M. N. H.

southern United States, certain localities in Mexico, Central and South America, and many Pacific Islands, including Hawaii. The annual production of rice in the United States is about 70 million bushels, or about one-fourth the barley crop. This amounts to about one-half bushel per capita, but since cooked rice expands 300% in bulk, the amount is of some importance.

North American Wild Rice

Our story would not be complete without some account of wild rice in America. This is a different genus of rice, *Zizania aquatica* and Z. *milicea*. *Aquatica* grows in single stems, five to ten feet tall, with panicles about two feet long. The glumes (husks) are about an inch long, containing long slender grains, of a dark slate color when ripe. The plants can adapt themselves to quiet water, two to eight feet in depth, preferably the margins of ponds, lakes, or flood plains of rivers with mud bottoms. Early in June the shoots appear above the water. They mature about August 1st, and the grain is ready for gathering in September. The early French explorers speak of this wild rice as wild oats, Indian oats, etc.

The plant is an annual and seeds itself, since the ripe grains are heavy and sink to the bottom when they fall. The main habitat of Z. *aquatica* is the part of the United States and southern Canada east of the 100th meridian west, an area roughly east of a line passing through Pierre, South Dakota, Dodge City, Kansas, and Abilene, Texas. The Indians who made the most use of wild rice were those of eastern Canada around the

WILD RICE, NATIVE TO NORTH AMERICA, was an important source of food to many Indians. It flourished without cultivation in the margins of lakes and on the muddy floodplains of rivers and was harvested in September. (Potomac River)

Fish and Wildlife Service photo

CHIPPEWA INDIAN in boat, tying wild rice. To protect the rice from birds and wind, the Indians laboriously tied the heads in bunches. Ducks of every variety, geese, and birds of all sizes and kinds found millions of acres covered with this pleasant food, while the Indians could gather but a small quantity, according to Mrs. Eastman, who described the aboriginal scene in 1853

Courtesy of the Bureau of American Ethnology

Great Lakes and Winnepeg drainage areas, tribes speaking Algonkin and Siouan.

A similar Asiatic species, Z. *latifolia,* has been observed in Siberia, Japan, Formosa, and part of eastern China. Although Z. *aquatica* is reported from the West Indies, it is not known in South America.

None of the North American Indians seem to have *sown* wild rice until after contact with white people. Since 1800, some of them are known to have stocked lakes and ponds when necessary, but once the plant was introduced, it needed no cultivation.

THE BINDING TWINE was threaded through rings attached to the jacket the woman wore when tying wild rice. From two to six miles of twine are estimated to have been needed by each family for tying one season's wild rice. Customarily the twine was made by shredding out long slender ribbons of basswood bark fiber and tying them together (From the Chippewa Indians)

Photos courtesy of the Bureau of American Ethnology

A NARROW BED of wild rice tied in bunches or sheaves

THE PROCESSING OF WILD RICE in America was in many ways similar to that of cultivated rice in the Orient. Here we see a Chippewa Indian treading rice in the familiar manner to remove the husks, but with two railings to take some of the weight off his feet

Courtesy of the Bureau of American Ethnology

The only attention the early Indians gave the crop was to tie the rice heads in bunches to protect the crop from birds and to prevent the wind from shattering out the grains. For this, they made twine of basswood bark fibre. Each woman, or family, used a slightly different tie and accordingly claimed ownership of the ripening rice.

The rice was gathered from canoes, poled or paddled among the rice stalks, the bunches of heads being bent over and the grain beaten off into the boat, as shown in one of the illustrations. The earliest accounts of rice gathering (1689) mention tying the heads but make it clear that much of the rice harvested was not tied but merely bent over the edge of the canoe, as shown in the drawing by Eastman. When a canoe was filled, it returned to camp, where the load was spread upon drying-frames.

The grains had then to be hulled by treading or beating. According to tribal custom, there were varying stages in these processes, since the drying frames might be smoked, the grains parched in a kettle, etc. The wild rice you purchase from your grocer has a smoky flavor if prepared in the Indian way.

Note that the main procedures in preparing wild rice closely parallel those for cultivated rice in the Old World. The two important differences are that in Asia rice is not tied in bunches to protect it from birds as was wild rice in America, and it is not smoked. On the other hand the American grain is not polished. In both areas the laborious processes are harvesting, hulling, and winnowing the grain. Like the Asiatics, the Indians almost never ground their rice but ate it boiled, usually with meat of some sort and frequently sweetened liberally with maple sugar. The Indians did not plant and

WHEN THE WILD RICE was ripe for harvest, the grain was beaten into canoes as shown in this drawing by General Seth Eastman, dating from the middle of the last century. To quote from Mrs. Eastman, the girls from an Indian village made quite a frolic of it

Eastman's Aboriginal Portfolio

weed their crops, but the labor of making twine and tying their rice was by no means a light task. Gathering the basswood bark and preparing the twine by hand occupied the spare time of the family during the winter months. We have estimated that from two to six miles of twine were needed by each family, the number of bunches tied ranging from 400 to 1600.

Indian Corn or Maize

The first human beings to discover America were primitive stone-age hunters from Siberia. The time was late Pleistocene, when the last of the huge elephants were still tramping through the swampy parts of North America; camels, wild horses, and tall long-legged bison could yet be seen in the

A.M.N.H. photo

WILD RICE from the country of the Ojibway Indians: above, threshed but not hulled; below, hulled and ready for storing or cooking

open grass lands, and the giant sloth was using caves as burrows suitable to his size. Other kinds of game more modern in character were there in plenty. Up until that moment none of these American animals had ever seen human beings, so they were ignorant of man's predatory nature.

Once in America, these invaders found themselves in a hunter's paradise, free from enemies of their own kind and surrounded by game easy to approach. The animals were similar to those of their homeland, but the plants were for the most part strange, inviting experimentation to learn their uses and dangers. All of these new objects and freedoms stimulated the savage mind; food was abundant, so the population increased rapidly. When a band of hunters became too large it divided, and the new band moved into the unoccupied country ahead. Old vocabularies were discarded and new words invented to designate new objects and relations. The tempo of life and health was stepped up. At least, this seems a reasonable expectation.

No wonder anthropologists found about 1500 different languages spoken in the New

A.M.N.H. photo

A In 1920 a quantity of ancient fodder was found in the ruins at Aztec, New Mexico, dated about 1120 A. D. by the tree ring method of chronology. During the lunch hour, one of the mules belonging to the workmen ate a large part of the fodder before discovered in the act. The ear marked A at right is one of the pieces from that cache

OTHER TYPES OF MAIZE IN THE EAR

B Pre-Columbian maize, fourteen rows of grains to the ear, in spiral. (From Arica, Chile)

C Modern maize, eight rows. Pawnee Indians

D Modern maize, eight rows. Iroquois
E Modern maize, eight rows. Pueblo, New Mexico

World, and though linguistic experts have been able to group these languages into about 175 families of speech, they have been unable to be sure of genetic relations between any of these families. Again, those who study the ways of living, customs, and habits of the many hundred surviving tribes of Indians, find them of great variety. The new methods devised by archaeologists are revealing that rapid changes occurred in ways of living even in the same localities, far too rapid to be correlated with changes in climate and other ecological phenomena. In the main, this welter of detail will be found consistent with the expected adjustment of successive generations of hunters to the changing local environments besetting their migration routes.

As the hunters spread southward, every now and then a favorite plant food would not be found in the next strange locality. Thus new problems would arise, such as: could plants be moved? When the Andes were reached, large game was probably less plentiful than formerly, but plants did not decrease, merely changed in kind. From a survey of the plants domesticated many botanists favor the Andean highlands as the place where good wild plant foods were most abundant and where newcomers would therefore find the greatest incentive to experiment in agriculture.

That maize was the first plant to be cultivated is unlikely but its wide distribution testifies that, once it was on the way, its merit was obvious. Certain caves in Kentucky and Arkansas have yielded evidence that agriculture was practiced long before the earliest appearance of maize in their deposits—for example, seeds of the domesticated sunflower, the giant ragweed, etc. Nor is it likely that any single plant can be proved to have been the first. Conditions being favorable in many localities, there may well have been spontaneous independent experiments with different local species of plants in different sections.

From the Codex Florentino

NATIVES of the Western Hemisphere did not know about the plow when Europeans arrived. Digging sticks and spadelike implements were the universal New World agricultural implements. This illustration is an Aztec drawing showing a farmer planting maize with a digging stick. The traction plow is an Old World device, assumed to have evolved from the digging stick

White maize grown by Iroquois Indians about 1905

List of Native American Plants of Economic Importance

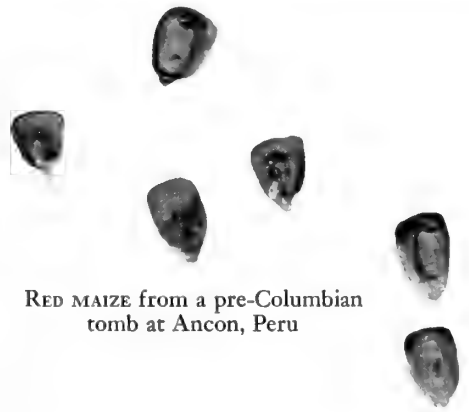
CULTIVATED

maize	potato
tobacco	peanut
manioc	sweet potato
pumpkin	tomato
cotton	sisal
avocado	pineapple
beans	chocolate
calabash	coca
chili	sunflower
ragweed	pigweed
barnyard grass	cashew nut
maté	cinchona

NOT CULTIVATED

rubber	pawpaw
copal	plum
Indian hemp	water lily
nettle	camass
basswood	mesquite
wild rice	acorn

That the Indian eventually selected food plants of extraordinary qualities is evidenced by the world-wide use of maize, the potato, bean, peanut, squash, cassava, pineapple, etc. The Old World can scarcely rival this list. So quickly were many of these carried to all parts of the world that it has been difficult to prove their New World origin, except by noting that their obvious wild ancestors were not found outside of the New World. Thus in Europe maize was first called "Turkish corn or wheat," for the same reason that the native poultry of the Aztecs is called *turkey*, even in America, because these foods were quickly adopted by the Turks and from thence introduced into Europe. In the same way, the name "Irish" potato concealed for a long time the South American origin of that important food.



Red maize from a pre-Columbian tomb at Ancon, Peru

Indian Methods of Growing Corn

When discussing wheat we noted that a general pattern of procedure prevailed from ancient times to the present. The same is true for corn. Everywhere within the corn growing area the Indian pattern was the same in outline, the sequence of processes were preparing the soil, planting the seed, protecting the crop, gathering the ears of corn, storing, grinding into meal and selecting the seed for the next planting. The usual tool for preparing the soil and for cultivation was the digging stick, in some localities taking the

form of a foot-plow, a spade, etc., but in parts of the United States a true hoe. Everything was hand work. The universal method was to plant four or five grains of corn in a hill, or at intervals in a ridge, except in very dry regions where the planting might be in holes or trenches.

It is curious to observe how closely white people, settling in America, copied the Indian methods of corn farming. They speak of the Indians as savages but still use their methods of growing and using corn.

Our farmers formerly planted, and often yet plant, maize in hills; this was the universal Indian mode, four or five grains being dropped at one place at regular intervals of about three feet, quite like a cornfield of today. In cultivation, the Indian hoed the earth up around the growing stalk, which is still the principle of the mechanical cultivator. For husking, our farmers use a husking pin, which, while now of iron, was not so very long ago of bone or wood, precisely like those still in use among our surviving eastern Indians. Ears of corn to be dried or preserved for seed often have their pendant husks braided together; this is typically Indian. The corn crib was used by the Indians and elevated on posts to keep the contents dry and to protect it from rodents. The type of

A MANDAN INDIAN GIRL of about 1700 A. D. cultivating maize with a hoe, made of the shoulder blade of a bison. The history of the hoe is obscure. In the New World it had a limited distribution in eastern United States but was unknown in our southwest, Mexico, and South America

Statuette by Paul Wright, in the American Museum

AN ANCIENT CORNFIELD UNCOVERED. Skillful excavating permitted archaeologists to expose the wavy surface several feet underground representing the orderly ridges of earth. This field was tilled by prehistoric Indians on what is now the Ocmulgee National Monument, Macon, Georgia. The early people later buried the field while landscaping for a ceremonial building

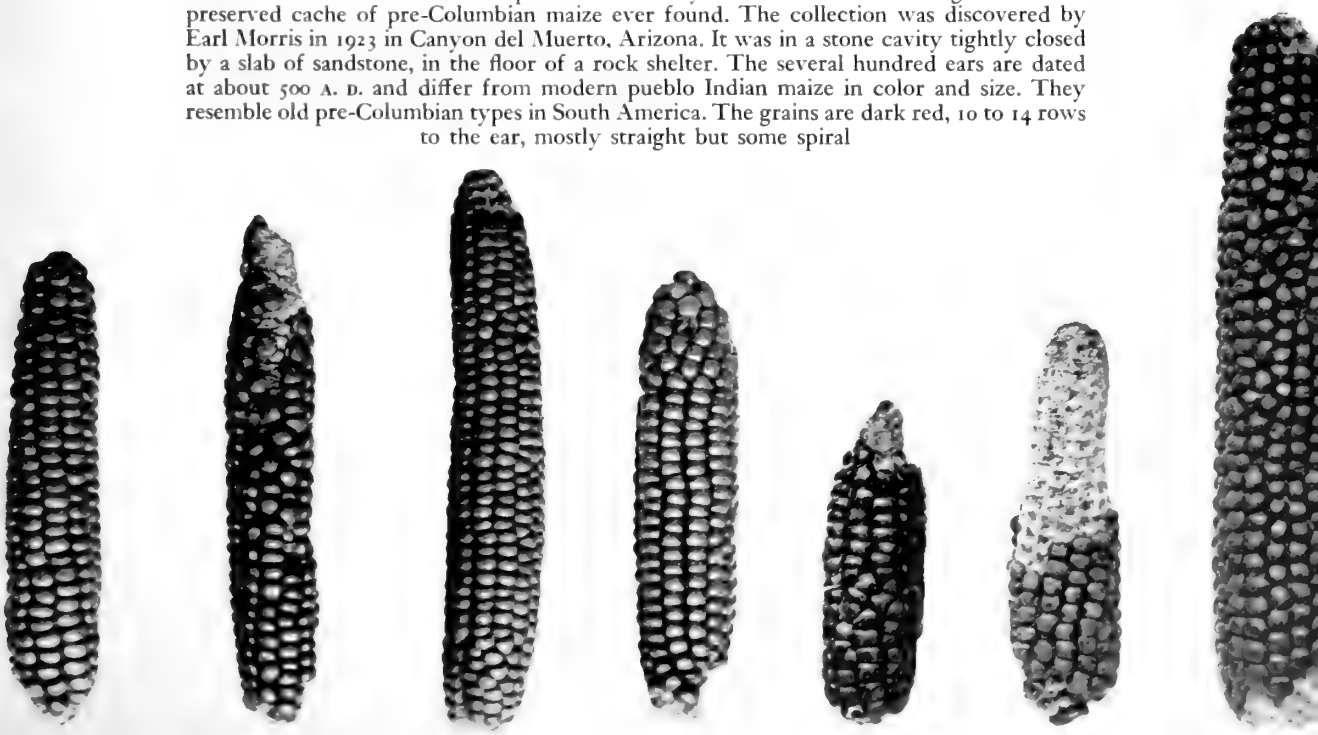
National Park Service phot

crib which is larger at the top than at the bottom was also in use by the southern Indians.

The Indian planted beans and squashes among the corn. This has always been a favorite custom of our farmers. He also understood the art of testing his seed and of preparatory germination in warm water. Where fish were available they were used for fertilization, the rule being one fish to a hill.

The methods of cooking corn are not only still about the same among us, but we also retain many of the Indian names for such dishes, as hominy and succotash. The famous roasting ear in all its forms was known to the Indian. Then we must not forget the favorite mush, which is stirred with a wooden ladle

RANGE IN SIZE at one time and place is shown by these ears from the largest and best preserved cache of pre-Columbian maize ever found. The collection was discovered by Earl Morris in 1923 in Canyon del Muerto, Arizona. It was in a stone cavity tightly closed by a slab of sandstone, in the floor of a rock shelter. The several hundred ears are dated at about 500 A. D. and differ from modern pueblo Indian maize in color and size. They resemble old pre-Columbian types in South America. The grains are dark red, 10 to 14 rows to the ear, mostly straight but some spiral



A.M.N.H. photo

EARLY PRE-COLUMBIAN MAIZE excavated by Junius Bird near Arica, Chile, showing tassel, root-node, ear, husk, and cob. Corn was cultivated many centuries ago and over a wide area in North, Central, and South America. But it was probably not the first agricultural product in the Western Hemisphere

strikingly like those of the Algonkin tribes. Some years ago our country people still made "lye hominy" with wood ashes, just as described by some early observers of the Indian.

Corn-husk mats may still be seen in some country homes. As I recall a few specimens examined, the technique was the same as the Iroquoian examples to be seen in our museums.

The one important innovation of the white man was the substitution of the mill for the mortar. Later, of course, came various kinds of machinery for the cultivation and gathering of corn, but all such machines are mechanical appliances to perform more expeditiously the same old processes. It is clear that in pioneer days the white farmer took over the whole maize culture-complex entire, except its ceremonial and social elements. Even here we find some curious similarities. The husking-bee, which was one of the great social events of our fathers' times, is strikingly paralleled by an old Indian custom. No doubt if we knew more of the homely history of our forefathers we should find some surprising intrusions of ceremonial and superstitious practices to propitiate the growth of their crops.

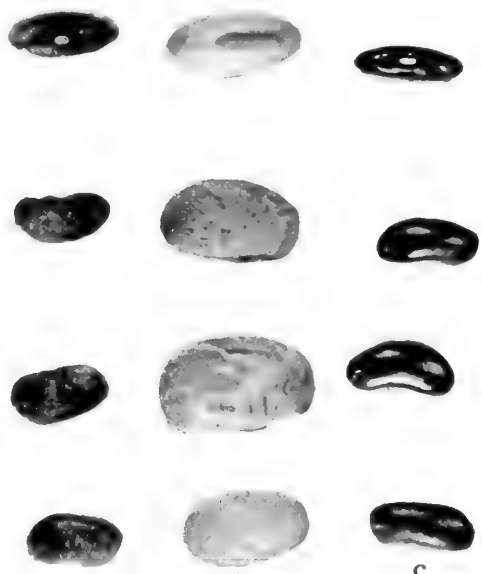
If we reduce these data to a generalization, it appears that the white colonist took over the entire material complex of maize culture. He did not simply borrow the maize seed and then in conformity with his already established agricultural methods, or on original lines, develop a maize culture of his own. In fact, he has no basis for any claims to originality except in the development of mechanical appliances and the somewhat recent rationalization of agriculture by scientific investigation.

In this connection the maize culture of the Old World is particularly suggestive. At the discovery of America, samples of maize were carried home, seed was planted, and in a surprisingly short time its cultivation spread even so far as China; but the maize complex of the Old World has scarcely anything in

common with that of the Indian and the American farmer.

When the seed of corn reached Old World farmers they considered it a cereal, which was correct, and accordingly followed the pattern for wheat and other cereals, sowing it broadcast so that the plants stood thick and crowded like wheat. The result was that the ears were small, but the crop made splendid stock food. People did not eat the grains because the meal did not make good bread like wheat. In World War I, the United States offered to send starving populations corn for making meal, but these well meant offers did not appeal to them; they did not

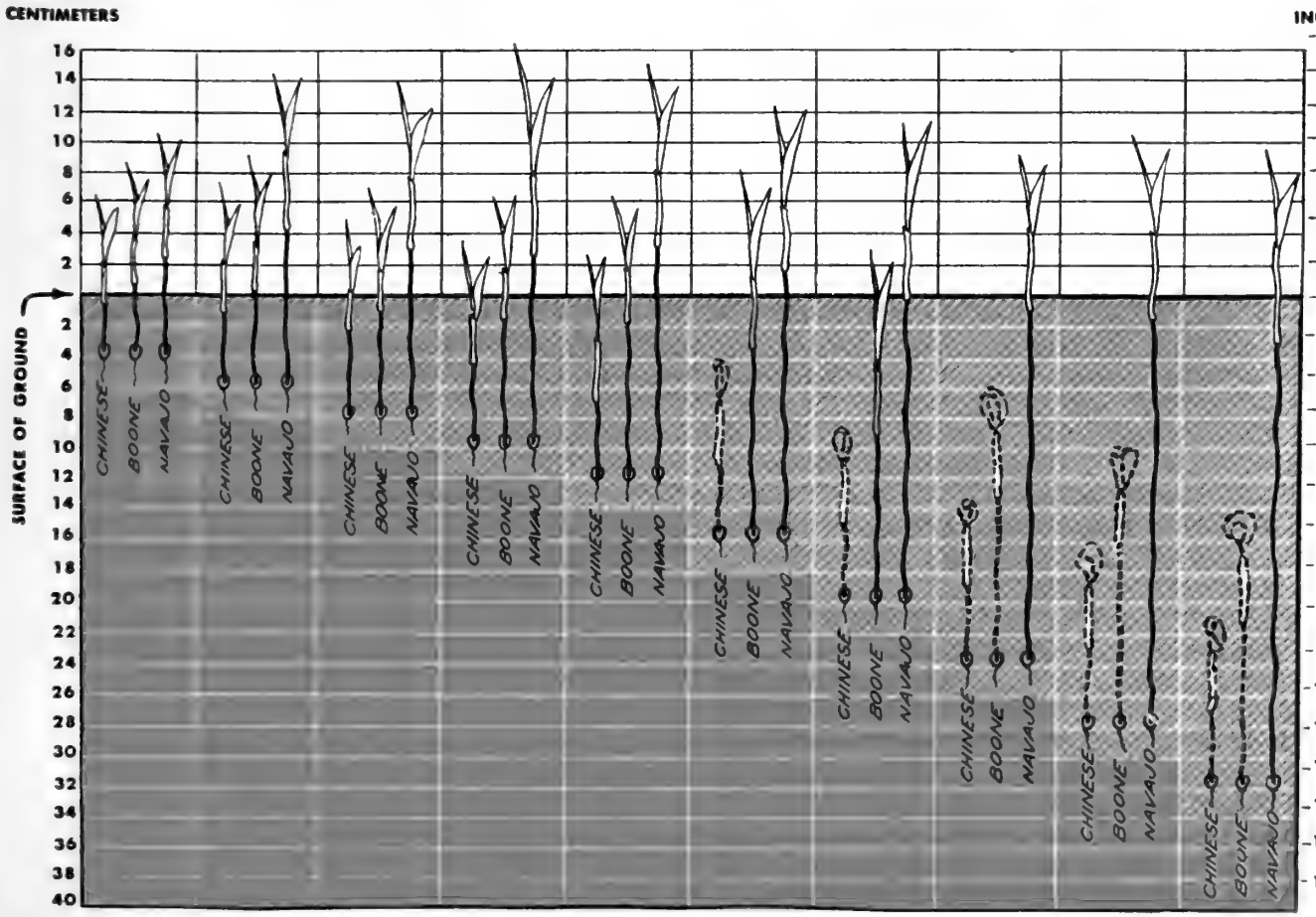
THE CULTIVATED BEAN is of New World origin. Two types grown in pre-Columbian times are compared here with a modern type
(a) Kidney beans from Surco, Peru
(b) Lima beans from Surco, Peru
(c) Kidney beans, Iroquois, about 1905



A.M.N.H. photo

SUPERIORITY OF NAVAHO MAIZE FOR DEEP PLANTING

PROOF that Navaho corn is adapted to planting at a depth of more than one foot (32 cm.). The type was developed by artificial selection for planting deep enough in dry sand for the roots to reach the yet deeper moist ground



After G. N. Collins, courtesy The Journal of Heredity

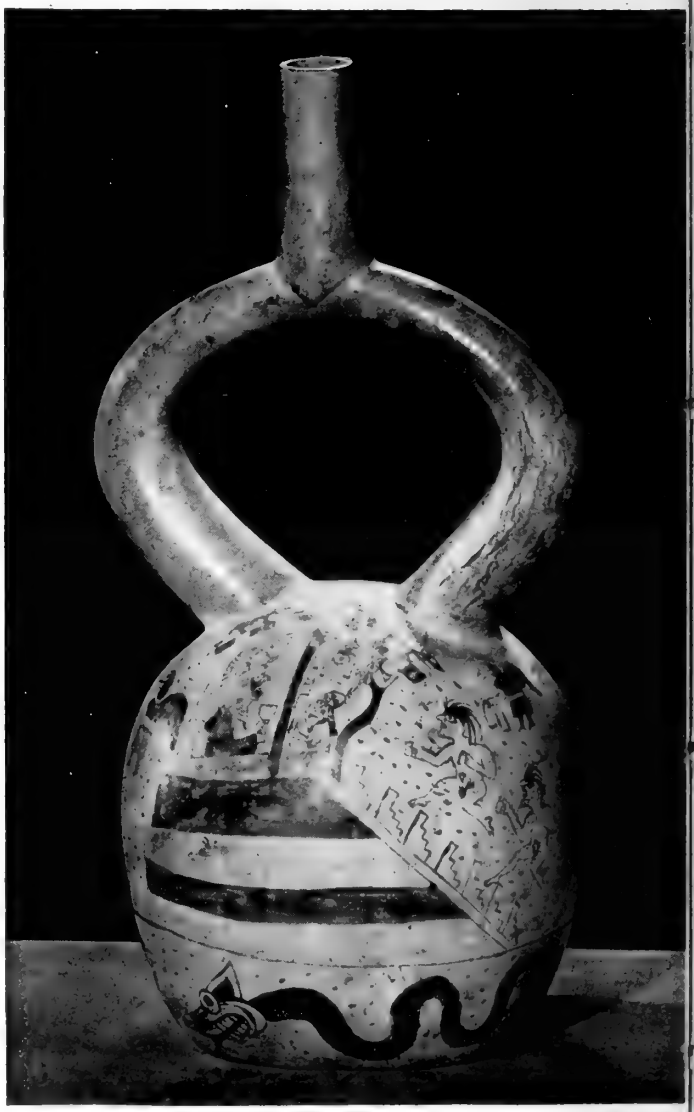
like cornbread and anyway we were offering them live-stock food instead of plain necessary wheat bread.

The reason is plain—it was the isolated plant that came into European culture, necessitating original experimentations with the new seed, or, at least, the adaptation of its culture to the methods or "patterns" for the raising of other plants. The first American farmers, on the other hand, found themselves projected into the midst of a new culture, where it was much easier to adapt trait-complexes than to invent them. It is more than likely that we are here illustrating two characteristic modes of culture diffusion: in one case a new object or an isolated idea is carried far afield and dropped into the midst of a strange culture group, and in the other the group itself is dropped into the midst of a strange culture, or merely brought into contact with it. In the latter, whole complexes will be taken bodily; in the former, a new trait will be originally developed or simply adapted to some already existing pattern.

The Weak Development of Animal Industry in Aboriginal America

That the farmers of the New World made the most of plant exploitation is clear. The intruding white population did not discover a single wild plant of outstanding economic importance not recognized and used by the aborigines. Even rubber was gathered in the Amazon country and produced in Mexico from the dwarf guayule plant.

The aboriginals were aware that animals could be tamed, but they failed to grasp the idea that the propagation of animals for their flesh was feasible. And in animals for traction the aboriginal score stands at zero. Was this due to blindness as to the virtues of the wheel or because suitable traction animals were



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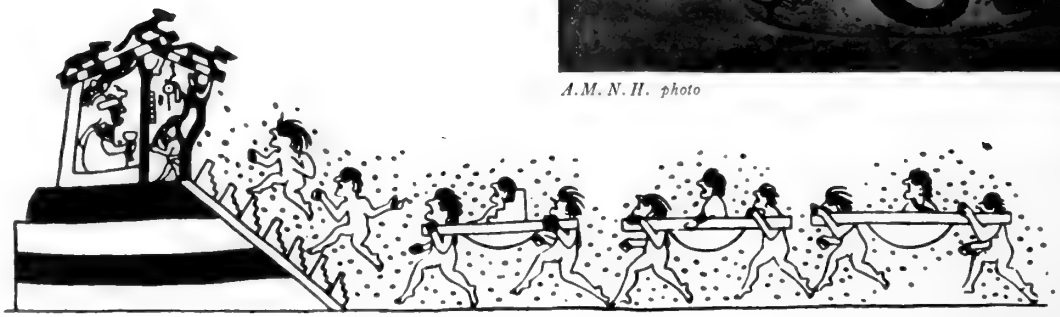


RAPID TRANSIT by manpower in old Peru: a jar and the drawing that decorates it (*below*). The drawing shows a dignitary surprised by unexpected guests, perhaps officials with captives from "the front." The dogs on the roof are behaving normally

Representations
corn on Peruv
pottery of the ea
Chimu Period, ab
500 A. D.

lacking? When we note that in ancient Mexico toy animal figures were made mobile by small wheels, the mystery deepens. The more primitive tribes in the bison area of the United States and the Eskimo of the Arctic used dogs for traction, the former with the travois and the latter with sleds in winter. The Aztecs had no burden-bearing animal; the Inca used the llama, which could carry a load of about 90 pounds. That tells the story. It is a poor showing in contrast to the ancient Old World with oxen, asses, horses, camels, elephants, etc., able to draw heavy loads and carry one or more persons upon their backs. The Aztecs were doomed to carry freight upon their own backs: the roads to Mexico City were lined with carriers, many with huge packs upon their backs for delivery to the Aztec tribute gatherers. Now and then came a trader with a troop of carriers, but most frequently men and women carried goods individually to market in the towns. Within the City of Mexico were numerous canals and then the lake, crowded with canoes similarly loaded, but over the country at large, freighting between cities and towns was back-breaking drudgery. Some of the rich were carried in litters, but most people walked, burdened with baggage.

We have praised maize as a cereal fit to implement a civilization, yet as a food, wheat makes a strong claim for being the No. 1 world's cereal. Above all it is still the leading source of bread. Maize was a good substitute, but its modern popularity rests upon its value as a stock-food. The weak point in Old World animal husbandry was the want of a satisfactory stock-food, but the world was quick to discover the superiority of maize for animals. So let us give the aboriginal American his due. He may have a poor record in the integration of agriculture and stock raising, but he compensated for it by contributing to the world the ideal stock-food, thereby bringing about an almost ideal integration of agriculture and animal husbandry, the one basic principle in maintaining modern civilization.

Origin of Maize

The wild ancestor of wheat was not discovered until about 1900; and as for maize, no wild plant has even yet been found which qualifies unquestionably as the original ancestor. The leading contestants for the honor are:

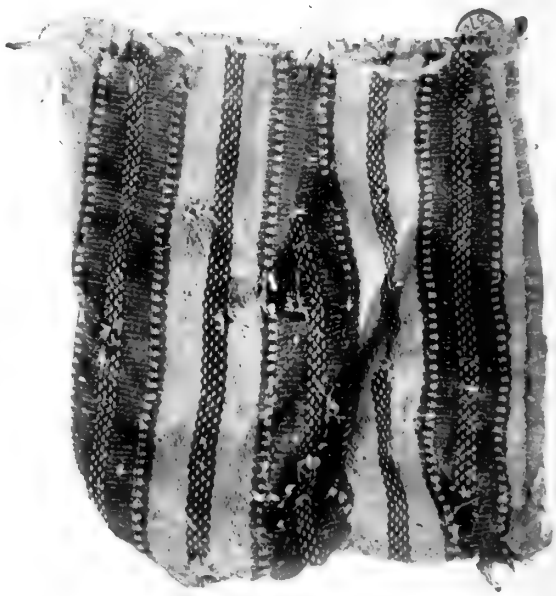
Teosinte (*Euchlaena mexicana* Schrad.)
Tripsacum (*T. dactyloides* L.)
Pod Corn (*Zea mays tunicata*)

Neither cultivated maize (*Zea mays* L.) nor Pod Corn has been observed able to propagate itself in a wild state. Neither do the traditions of Indian tribes nor early colonial documents give much help in recovering the lost history of maize. The first explorers found it grown from Maine and Quebec on the north, to Florida on the south, in the Mississippi valley, in the West Indies, in the lowlands of South America, in the Andes, and as far south as Patagonia. Archaeology has proved its antiquity in our Southwest, Mexico, and the Andean countries (*see map p. 39*).

Perhaps no other domestic plant has been subjected to as much exhaustive botanical research as maize. Many experimental agricultural stations have made such research a major part of their respective programs, a large fraction of which have been concerned with a search for wild ancestors, because of the need for a clear understanding of maize genetics. Yet the mystery remains. However, the intricate detailed knowledge of maize chromosome patterns does make some suggestions. The tendency now is to assume a South American Andean highland origin for its first cultivation, and so prevails the still unrealized hope for finding a wild ancestor somewhere in that area.

Maize is regarded as a grass, prone to cross with a wide range of other grasses. Further, domestic maize still reveals flexibility to environment, rendering its specific adaptation to local conditions easy.

THE OLDEST KNOWN POPCORN. The well-popped grains were still fluffy white when found in the adjacent bag attached to the belt of a mummy in Chile. The popcorn was probably left as a mortuary offering. The horny shells remaining show that the kernels were deep red



A.M.N.H. photos

On the other hand, the original Indian type of maize possesses a vitality equal to the preservation of its essential qualities, even though cultivated for centuries by the more primitive hunting tribes of the marginal maize areas. The surviving modern types were produced from seed originally taken directly from Indians in eastern United States. The several recognizable modern varieties are:

Pointed popcorns
Dent corns
Flint corns
Flour corns
Sweet corns

The latest theories about the origin of maize are chiefly of two types:

(a) that it originated in Guatemala in the cultivation of a wild grass, teosinte or tripsacum;

(b) that the Andes was its home and that the ancestor was a form of wild pod corn not yet identified.

The modern approach to the solution of the problem is through the study of chromosome patterns in the germ cells. The most recent work by P. C. Mangelsdorf and his students suggests that the earliest form of maize was propagated in South America as a hybrid, which spread throughout the Andes, finally reaching Central America; there it was again crossed with a related wild plant, finally reaching into the valley of Mexico, where once again it crossed with a wild grass. Thence, some of this seed passed into the West Indies and southern United States, to be returned to the Andean highlands, all in pre-Columbian time. The arguments used in debating these theories are too technical to be understood by anybody except a few experts in the genetics of modern maize.

Pod corn, one of the three contestants for the honor of being the ancestor of maize, here shown in a pre-Columbian ceramic replica from Peru. Each grain has a separate husk as is usual among grains. But pod corn has never been observed to propagate itself in a wild state

The Geographical Setting

We noted that civilization in the New World began in the central part of the land mass (*see map*). Mexico, Central America, and the Andes highlands are neighboring regions. However, if we look at separate single complexes of living habits, some of

Thumbnail sketch of the area in which city-states prevailed, including the Aztec and Inca nations, with outlying areas. This map is also the key to events since 1492. Spain had the lead in exploration, so seized all of area A. England finally came to control all of B and C in North America, and Portugal most of B2 in South America. The independence of the United States and countries to the south explains why we have two Americas—English-speaking America (Canada and the United States) and Latin America (Spanish- and Portuguese-speaking countries to the south)

them will show a wider geographical distribution than others. For example, the cultivation of maize in 1492 will show a wider distribution than many other traits of the Aztecs and the Incas.

Further the simple map we present tells the story of the evolution of society in the New World as of 1492. The two great city-states, Mexico City and Cuzco, ruled over the greater part of area *A*, comprising in all many smaller cities and towns more or less subjected. The boundaries between Inca and Aztec lands did not overlap but were widely separated in Colombia and Central America by intervening towns and cities. Area *A* on the map defines the region of intensive culture and the sphere of influence of the Incas and the Aztecs in 1492.

Thus this crude little map not only tells what happened here before 1492 but is the key to what happened since. It seems to make the fundamentals of American history so plain that one pauses in astonishment that the teaching of history even in our elementary schools should not have adopted this device from the first. Our grandfathers were fond of the expression "a thumbnail sketch;" this is an illustration of what they had in mind. If the reader has been able to grasp the significance of this map, he need not be a specialist in American history to "know where he is at."

What Might Have Been

Almost everyone who reads a short account of the evolution of these New World civilizations, spontaneously frames the same question: If Columbus had failed and America had remained isolated for another 2,000 years, what would have happened? Attempts have been made to answer this question. It is inconceivable that no advances would have occurred. On the other hand, the discovery of America was inevitable, because Europe had awakened, ships were at hand capable of long voyages, the idea of the rotundity of the earth was not only accepted by many learned contemporaries of Columbus but the proofs of the theory were considered sound. At most two more centuries would have brought the solution to what lay beyond the western sea. So such speculation is futile.

Summary Comment

WE HAVE now passed in review the three outstanding cereals of the world. First let us attempt a comparative view of wheat and corn (maize). Each seem to be a fundamental trait in a pattern of civilization. Yet the American aboriginal pattern of Middle America and the Andes had few new traits to contribute to the Old World pattern, except a number of domesticated plants. Relatively these were no mean contributions to modern diet and economics, as we have stated. Human life is so varied and rich in detail that we often despair of discovering a simple scheme of classification realistic enough to be useful, but one of the most satisfactory in the sphere of human geography is the recognition of the three great cereal areas, wheat, rice and maize.

Minor Cereals

To acquire a more complete picture of man and his cereal foods brief note should be taken of a few of the best known secondary food grains. Curiously enough, for the most part these are submerged in the over-all pattern of Old World civilization, seemingly originating in parts of the great wheat area. (Map p. 17) We defined that pattern as embracing such elemental general concepts as cereals, plow, wheel, writing, etc. In time rice came to dominate an area of its own, apparently due to environmental conditions, but otherwise the civilization pattern was generally similar for the Old World as a whole. Yet the totality of the New World pattern embraced minor cereals, also, which were not taken over in a large way by the Old World civilization, as in the case of

maize, and a few other cultivated plants, such as tobacco, beans, etc. Among the New World domesticated grasses, whose seeds could have become minor cereals, were barnyard grass, the giant rag-weed, pigweed, sun-flower, etc., yet they did not successfully compete with rye, oats, buckwheat and millet either as stock food or cereal substitutes.

Millet

The millets of the present and of antiquity comprised a variety of grasses of different genera, including the sorghums and Kaffir corn. What appears to be the original millet (*Panicium milaceum*) appears archaeologically in the ancient wheat area. At Ur it appears before wheat and barley. Chinese traditions give millet priority over wheat. Its cleaned seeds are found in the remains of the Lake Dwellers of western Europe and it was known in Mediterranean countries during Greek and Roman times as contemporary to wheat and barley. It spread into Egypt and North Africa and the sorghums penetrated deeply into central and south Africa. Millet was known in India and parts of southeastern Asia. The tendency is to consider millet the first grain to be domesticated and so to have priority over wheat. It did not reach America until after 1500 A.D. where the various plants passing under that name are grown as livestock foods.

In the Old World the plow is possibly older than wheat; if so, its invention may be credited to the millet farmers. Chinese tradition seems to regard the millet farmers as the originators.

Barley

Barley is one of the ancient cereals, possibly older than wheat since it appears in some ruins before wheat. It was known in China before 2800 B. C. but possibly not before wheat. Anyway barley competed successfully with wheat which reached China at about the same date. Of course, the invention of yeast bread put barley second on the preferred list, but it has survived as a food and today is preferred for beers and ales. As a rule it matures earlier than wheat. Bread of a fashion can be made from its flour, but cracked it can be boiled and served as a gruel. In colonial times it was a favored food in the middle Atlantic Provinces. Even now it is popular in broth. In South America the surviving Indians of the Andean countries raise it because it gives a crop earlier than maize or wheat.

Rye

The origin of rye is obscure but the wild plant has been observed in many parts of the north temperate Old World. It is hardy, thriving at high altitudes, and has not been sufficiently domesticated as to prevent its running wild. In Europe it was called "blackwheat," probably because the grains are dark. They are usually smaller than wheat. When wheat was planted in unfavorable latitudes and altitudes, rye often intruded, surviving even when the wheat sown failed to make a crop. It is possible that the cultivation of rye began in this way. However, its appearance is relatively late so no claim for priority is made for it. As we have stated rye makes passable bread, but black and heavy in contrast to wheat bread. In America the tendency is to mix wheat flour with rye, thus making the bread lighter in color and weight. In northern Europe where rye can be raised more easily than wheat and barley, its bread is known as "black bread." In late historic times rye has been in demand for distilling liquors. Its straw, also, is superior for thatching and braiding.

Oats

Oats is a general name for a family of grasses many of which are still undomesticated. Its domestication is not ancient and the tendency is to regard it as the youngest of

the cereals. In the main oats is valued as a live-stock food, both for grazing and feeding as a straw and seed crop. The husks of oats adhere to the grain similar to rice, and when used for human food, oats must be hulled by special processes, and crushed (groats) or ground into meal. The country first specializing in the use of oats seems to have been Scotland, though great quantities are produced in the United States and Canada, chiefly for horse food. Yet under the name oat-meal it is one of our best known breakfast cereals. Oats grows best in northern latitudes, can be sown early in the spring and matures quickly.

Buckwheat

Buckwheat was probably first domesticated in China at a remote date and was grown in India, where one species seems to be native. However, the common buckwheat was wild in southeast Russia, west and central Asia. Apparently it came into western Europe through Germany, its German name being *Buchweisen*, so designated because the seed is shaped like a beechnut. In England and the United States the name was corrupted into buckwheat, probably because it was a possible substitute for wheat. At this point attention may be called to difficulties the first settlers in the United States encountered in attempting to grow wheat. New diseases attacked the growing wheat against which the plant had no acquired immunity, the result being such frequent failure of crops, as to force the colonists to find substitutes. The natural recourse was maize as grown by the Indians, hence it is understandable why corn-bread and hominy became the chief pioneer foods. Even when wheat survived the yield per acre was much less than for corn or maize. Buckwheat gave a high yield and was not troubled by disease. Also it was quick growing and its food value high. Another distinct advantage was that the

A SEED-GATHERING BASKET AND BEATER from the Paiute Indians of Nevada. The basket is shaped so that the edge can be held low and the grass stalks bent over it and shaken by the beater. Again, the beater may be used to catch falling seeds and transfer them to the basket

ILIAWRA women in Australia collecting grass seed from ant's nests

ALL of the world's modern production of wheat, corn, and rice has grown out of the primitive occupation of collecting grass seed. Today we can still see this elementary activity among the naked, hungry Australian "blacks," as shown in these drawings. For thousands of years, primitive women have thus gathered food—a seed or two here, another there—at great cost in toil and patience and with a return so trifling as to transcend belief

gluten content of buckwheat flour was sufficient to make yeast bread.

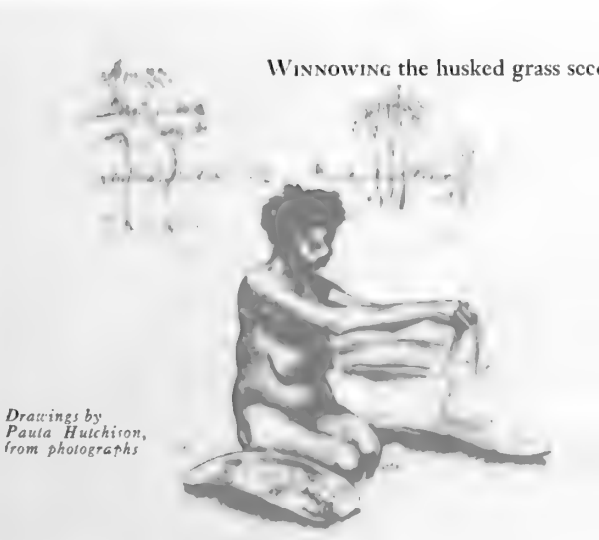
So we find buckwheat a popular crop in New England, New York, Pennsylvania and the northern tier of states. Furthermore, it is quick growing and therefore popular in Canada. Another advantage lies in its value as a live-stock food. Since 1930 production in the United States has declined rapidly, but it is still popular for griddle cakes. In the Ohio valley farmers soon learned that barley was ready to harvest before wheat and that if buckwheat was sown promptly it would mature before frost and thus the same field could produce two crops in one season.

The Gathering of Wild Seeds

It is logical to conclude that a long period of subsistence upon uncultivated seeds preceded all attempts to domesticate seed plants. Looking backward over these pages it appears that the period during which man merely gathered the wild foods that nature offered at the time and place, without cultivating the plants, was by far the longest span of time in human existence. During this long primitive period man overran all the habitable parts of the earth and met up with almost every variety and species of seed-bearing plants. The opportunity for experiment was almost boundless. In turn, the habitats of these grasses were spotty and highly localized. By trial and error; man probably came to recognize the most important species of seed-bearing plants in his habitat and sought to devise more and more convenient ways of gathering, processing, and cooking them.

Even from the first he seems to have been a *gourmet*, putting himself to a bewildering routine of trouble and toil to improve the

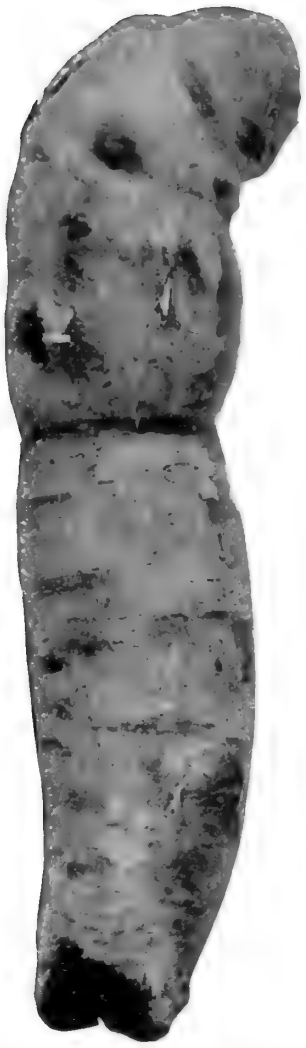
TREADING the grass seed to husk it



WINNOWING the husked grass see

Drawings by Paula Hutchison, from photographs

THE SIMPLE but exacting routine of converting grass seeds to food is everywhere the same: (A) find the ripening seed, (B) strip the grain from the stem, (C) hull it by treading, (D) winnow out the chaff, (E) pulverize the seeds, (F) combine with water to form a paste, (G) bake or toast on a fire



ACCORDING TO ONE THEORY, MANIOC was the first plant to be domesticated in the New World. That it is a good food for man and beast is clear from its popularity and wide modern use under the names cassava, sago, and tapioca. It is easily cultivated and well suited to people on the level of a hunting economy. Originally grown in eastern South America and the West Indies, it has been introduced to the natives of tropical Africa and other parts of the Old World. Civilized peoples grow it for stock-food where the climate is suitable. The root is pulverized and dried, providing a good cereal substitute

A.M.N.H. photo

raw products offered by nature. His fellow creatures were content to take seeds as they found them, but not he, as in the words of the most ancient of sages, "He prefers to earn his bread by the sweat of his brow." Even the way of the savage is the hard way. Hours and hours of patient toil are given to the preparation of what is eaten in a few minutes.

Fortunately for us, not all peoples of the earth became civilized at once. The understanding of our subject is made possible by comparing the ways of the nonagricultural peoples with the civilized. Thus in the United States we can still observe Indians gathering seeds as they did centuries ago, particularly in the semidesert lands of Arizona, Utah, Nevada, and southern California. The Paiute tribes, armed with simple ingenious basketry devices, strip seeds from many species of wild grasses, winnow out the chaff, and store the tiny seeds for grinding into meal and eventually baking in cakes, or more frequently for thickening soups. Seeds of more than 50 species were gathered by the Paiutes alone, which about exhaust the list of local wild grasses. Civilized men and women will not bother themselves over such small returns for the labor involved.

In a large part of semiarid Australia, where there is sparse vegetation and grasses, it is not surprising that the natives recognize the food value of even the smallest seeds. They carefully gather and conserve them, grinding them between stones and making cakes with the meal. It should not be overlooked that arid lands also bear numerous root plants whose bulbs are dug out with digging sticks. This is true in Australia as well as in the habitat of the Paiute Indians of the United States. Thus the popular contemptuous name "Digger Indians" is said to have been applied to many tribes west of the Rocky Mountains because they were so often seen digging in the ground for food. Some Australian explorers have written that the ground around a native encampment was so upturned as to suggest that a drove of pigs had been rooting up the place. Even Captain Lewis (of the Lewis and Clark Expedition) found the Nez Percé Indian women who were camped along the Columbia River so busy pounding roots that the noise reminded him of a nail factory.

But we are now concerned with cereals or seed grasses. We have reason to suspect that a long period of experimentation with wild seeds was necessary before success was achieved in producing the world's three great staple foods—bread, (wheat, barley, and rye), hominy (maize, hulled by boiling in wood ashes), and a bowl of boiled rice. Partly because of the large role that grasses have played in providing food for man, the semiarid lands are more often thought of as the place where agriculture began. Many root crops seem to stem from forest flora, but not all of them do. Tree-crops are chiefly of forest origin, but man probably planted

grains before he planted anything so slow-growing as a tree. Plants of aquatic origin, including rice, tend to have forest homelands, but grains of the millet-wheat group seem to have been native to uplands tending toward aridity. Further, their cultivation appears to have been more ancient than rice. It is therefore most probable that the cereals and civilization developed in favorable spots in a semi-arid environment and that the development of rice was stimulated by the successful exploitation of wheat. These assumptions are at least consistent with the locations of the earliest known civilized towns of any size. Civilizations are not conceivable without relatively dense populations, which in turn depend upon agriculture.

The Archaeology of Agriculture

The archaeology of plant foods, wild and domesticated, is only beginning to unfold, but the world is awakening to its importance and there is promise of new knowledge, like the twilight before a glorious dawn. Within another decade or two those who survive us will write a thrilling account of this new chapter in the science of man. Even now scraps of information are worth citing. We recall one of the latest contributions to the knowledge of plant foods of early man. Most of you have heard of that famous cave in China in which were found the remains of Peking Man. Embedded in the debris of that cave were masses of cracked shells of seeds which botanists have identified as hackberry (genus *Celtis*). A modern form, *Celtis occidentalis* var. *crassifolia*, still grows in western United States, especially in semiarid districts. Similar hackberry seeds are found in deposits of the Pleistocene or Ice Age in South Dakota and in north China. The mere presence of the cracked seed shells in the cave does not prove that they were eaten by man. Rodents could have carried them into the cave. However, Ralph W. Chaney of the University of California sought to solve this problem in a scientific way. He offered modern hackberry seeds to rodents and monkeys of several different species. Most of the rodents ignored them, but the few that ate them merely gnawed small holes into the shells to extract the kernels, whereas the shells in Peking Man's cave were crushed to fragments. The monkeys chewed the seeds and spat out the shell fragments, which were similar to those in the cave, but there is no archaeological evidence that monkeys lived

Photograph courtesy of C.M.Goethe, in Sierran Cabin. . . from Skyscr

THE MODERN cultivated sunflower and the wild sunflower compared: an illustration of the improvement that can be accomplished in a plant by primitive farmers. Cultivated seed heads as large as any now grown have been found in pre-Columbian rock shelters in Arkansas and Missouri. The Indians of eastern United States were observed growing sunflowers by the first colonists. They ate the seeds parched and ground into flour and extracted an oil from them

in the vicinity of the cave when Peking Man was there. Since even modern Indians in western United States eat hackberry seeds, Professor Chaney gathered information from them. He found that their method was to crush the seeds between stones to secure the kernels and that the resemblance of these fragments to those from the cave approached identity. We do not know whether Peking Man chewed the seeds or crushed them between stones, but since he used simple stone tools, it seems fair to assume that he gathered hackberry seeds and carried them home to crack at his leisure.

Diggings by archaeologists almost everywhere have brought to light the charred remains of grasses and seeds, and botanists have usually been able to identify them. In the previous discussions on wheat and maize we have mentioned such findings. In the submerged remains of Swiss lake dwellings were found charred and natural remains of many cultivated plants, including wheat, barley, rye, oats, millet, celtic peas, and carrots. By such finds it has been possible to distinguish between the horizons of agricultural and nonagricultural peoples.

In the New World we now find special published articles on the pre-history of cotton, beans, peanuts, sunflower seeds, gourds and squashes, tobacco, maize, etc., each a fascinating chapter in the unwritten history of the world. One conclusion to be drawn from such data for the United States is that other kinds of agriculture were practiced in Kentucky, Tennessee, Missouri, and Arkansas long before maize was introduced into that region. In fact, the last crops to appear were maize and tobacco. Long before they were grown, sunflowers, squashes, gourds, and seed plants were a part of the agricultural economy of the tribes. A recent publication by George F. Carter * tells how the new data resulting from preserved seeds and fragments of the *Cucurbita* (gourds, squash, pumpkin, etc.) suggest that their cultivation in southeastern United States long preceded maize in the same area and that they found their way in pre-maize times into New Mexico and Arizona. In general, this new information fully justifies the belief that agriculture in the New World was developed independently and without influence from the Old.

The Domestication of Animals

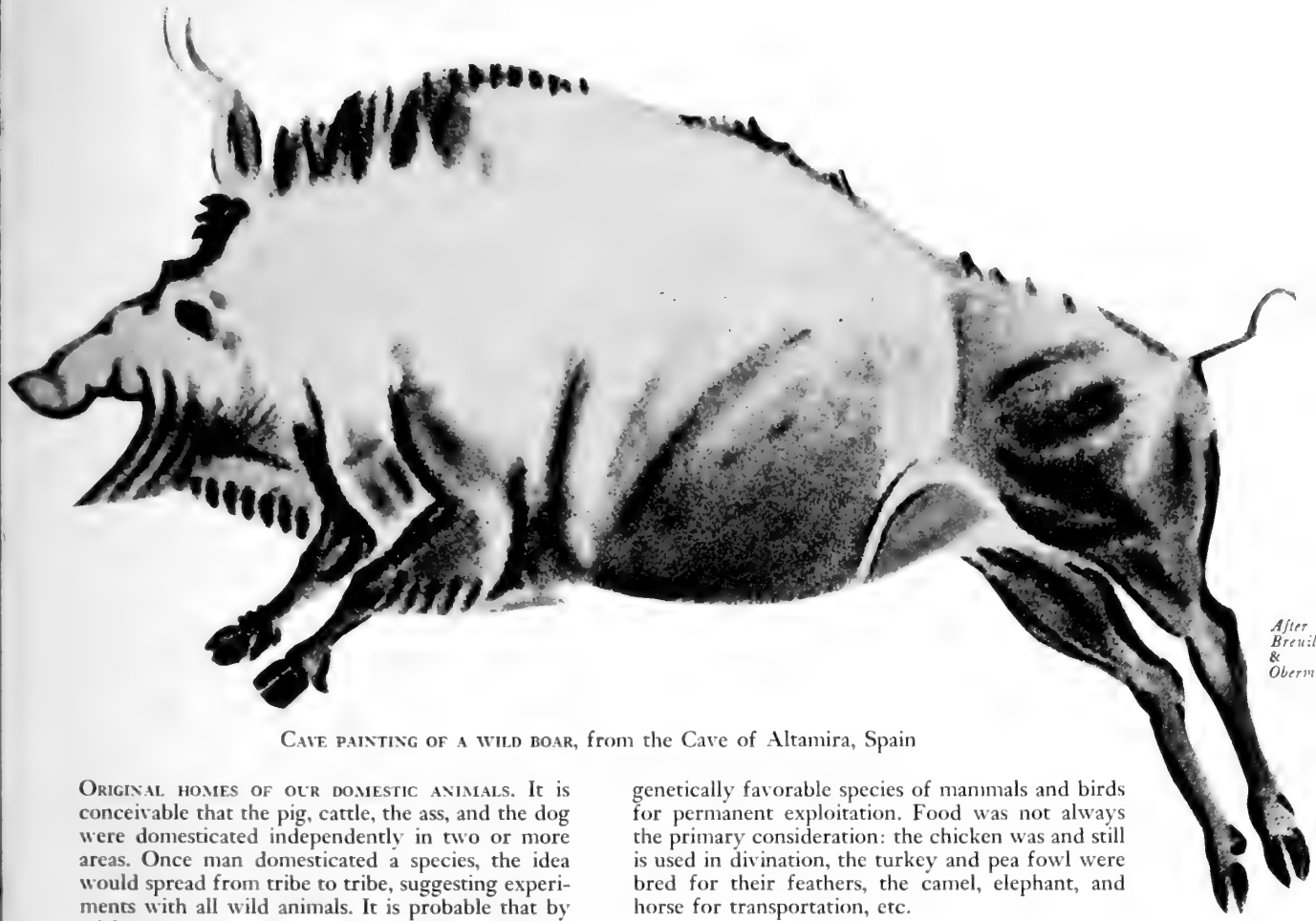
In the course of the foregoing review of man's achievements with the cereal foods we have often found it impossible to avoid some comment upon the closely integrated practice of domesticating animals, and it seems necessary that a brief look at the history of some obviously important farm animals should be appended.

When you begin to think about the domestication of animals you are moved to make certain assumptions. You take for granted that there was a time when no one anywhere thought of taming an animal; then you may try to guess what animal was the first to be tamed and compose an imaginary set of plausible incidents leading to the acquisition of a fireside pet.

You have a right to speculate in this way and may expect that most of your guesses have been made time and again by hundreds of other people. If you experiment by asking friends their guesses as to the first animal domesticated, you will find that many of them will choose the dog. They will be prepared to defend the proposition by such statements as: "Most savage tribes have dogs," "It seems most natural that man and dog should take to each other," etc.

In modern civilized life the term animal husbandry is used to designate the rearing of animals of economic importance. This, of course, includes those that produce meat, milk, hides, wool, and hair, or furnish power for traction and transportation, such as, cattle, horses, asses, hogs, camels, sheep, goats, reindeer, poultry, etc. While it is correct to say that the first domestications of such ani-

* *Plant Geography and Culture History in the American Southwest*, Viking Press, 1945.



After Breuil & Oberma

CAVE PAINTING OF A WILD BOAR, from the Cave of Altamira, Spain

ORIGINAL HOMES OF OUR DOMESTIC ANIMALS. It is conceivable that the pig, cattle, the ass, and the dog were domesticated independently in two or more areas. Once man domesticated a species, the idea would spread from tribe to tribe, suggesting experiments with all wild animals. It is probable that by trial and error, man selected the most tractable and genetically favorable species of mammals and birds for permanent exploitation. Food was not always the primary consideration: the chicken was and still is used in divination, the turkey and pea fowl were bred for their feathers, the camel, elephant, and horse for transportation, etc.

mals were prehistoric and therefore shrouded in mystery, we should recognize that paleontology and archaeology do furnish some pertinent data for a few sound conclusions as to when and where the rearing of the most important animals was first achieved. Since we assume there was a time when the ancestors of modern man were in most respects wild men living among the wild ancestors of our domestic animals, it may help us to look backward to see what wild beasts were their contemporaries.

Paleontologists and archaeologists seem to agree that the earliest human bones known are those of *Homo mojakertensis*, found in Southeast Asia in fossil beds of Early Pleistocene time, the geologic period that began approximately a million years ago. However, the human bones to which we have referred are from fossil beds in late Early Pleistocene time. Among the wild animal bones in these same beds were earlier representatives of the animals we know today as elephants, horses, cattle, deer (two kinds), and camels. Pigs appear with man in middle Pleistocene time; sheep, wolves, foxes, etc., appear with other human bones in the late Pleistocene. Thus it is clear that species of the great families from which the world's livestock was derived by domestication were characteristic of Pleistocene time. And the first men we know anything about (six or seven extinct species of man) were a part of the wildlife of that era and preyed upon these wild animals, at least as soon as they learned to use fire and make crude tools. There is every reason to assume that increasing human population spurred early man to hunt in teams and to stalk the larger animals, driving them into bogs, over cliffs, and into pits dug for the purpose. Fire was obviously one of the most powerful weapons in this cooperative trapping and killing of game. Positive evidence of fire appears with man of the Middle Pleistocene in Eastern Asia and persists through Late Pleistocene to the present. Its use may not be as old as stone tools and speech but is relatively very ancient.

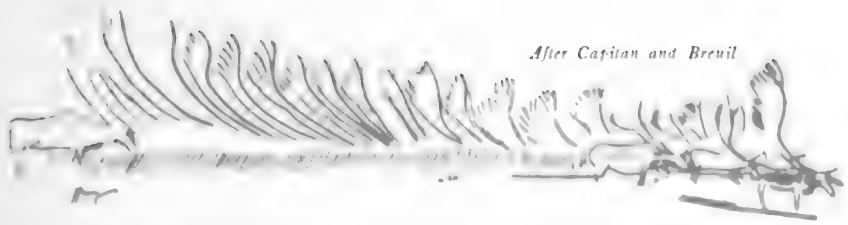
Another assumption upon which there is general agreement is that the invention of agriculture and animal husbandry came at a relatively late date and must be credited to *Homo sapiens*, the human species to which we belong. Archaeologists have observed no signs suggesting the domestication of animals or plants by any earlier but now extinct species.

If the reader is interested in possible biological evolutionary changes in man's structure and function, he should note this coincidental advent of a new human species and such a revolutionary way of living as the domestication of plants and animals. There is a puzzle here. The use of speech, fire, clothing, dancing, and many other fundamental inventions are credited to extinct species of man. Was it necessary, then, that the world wait for a new species to evolve before another series of epoch-making inventions were achieved, few, if any, of which appear more difficult than those preceding? If there are such things as true paradoxes, this may be one of them.

Order of Domestication

The usual assumption is that the dog was the first to be domesticated. One of the supporting arguments is the almost world-wide distribution of the dog. There is a widely accepted theory that the larger the geographical distribution the greater the age, though no critically minded person regards such evidence as infallible. However, the dog is the only domestic animal common both to the Old and the New World in ancient times. Even so, the dog appears late in the archaeological record, about on a level with agriculture in the Old World. In the New World his remains appear relatively late; they are conspicuously lacking in the sites associated with extinct animals, as at Folsom, Clovis, and the Strait of Magellan.

Turning back to the Old World, the pig seems to rank next in extent of distribution, reaching the far western and eastern margins



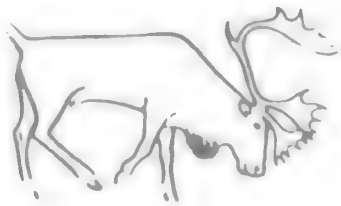
After Capitan and Breuil

A CAVE ARTIST'S IMPRESSION of a herd of wild reindeer, engraved upon an eagle's bone, Magdalenian time, France

of the land mass, and extending into the Pacific Island area. A number of species with local distributions seem to have been domesticated, whereas with most domesticated animals the tendency was to exploit a single species, which was then spread abroad by man himself, suggesting a single source of origin. In fact, whenever more than one species of ancestor is suspected, the scientist feels impelled to assume independent centers of domestication.

Somewhat smaller distributions belong to cattle. And we have some archaeological evidence suggesting still later dates for the domestication of most of the other domestic animals, such as reindeer, horse, ass, sheep, goat, camel, elephant, poultry, etc. In this way the following time sequences have been proposed: (1) among the first, the dog and the pig, (2) next in order, cattle and reindeer, (3) sheep before goats, (4) the ass before the horse, and (5) the horse before the camel and the elephant.

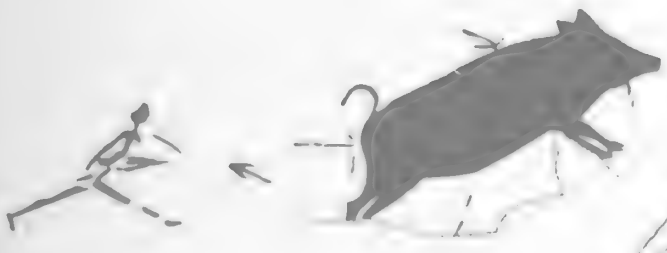
ENGRAVING OF A WILD REINDEER: European cave art. This is the most famous sketch of its kind



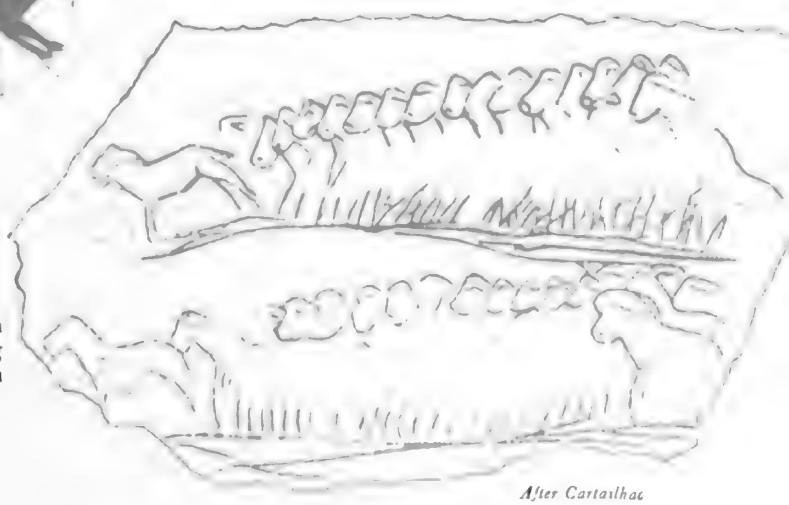
After Keith Henderson, in Primitive Man, *E.P.Dutton & Co.*

In much the same way the ranges of the wild species suggest the places of first domestication, as shown in the map on page 47.

For the dog, two separate derivations have been proposed,—jackal and wolf. For horned cattle, three localities are offered, and possibly as many subspecies,—the steppes, the valley of the Euphrates, and forested parklands in Europe. In the case of the pig, several localities ranging from Spain to Burma are suggested. Yet these are still little more than hypotheses. In the New World the dog seems to have been introduced from Asia.

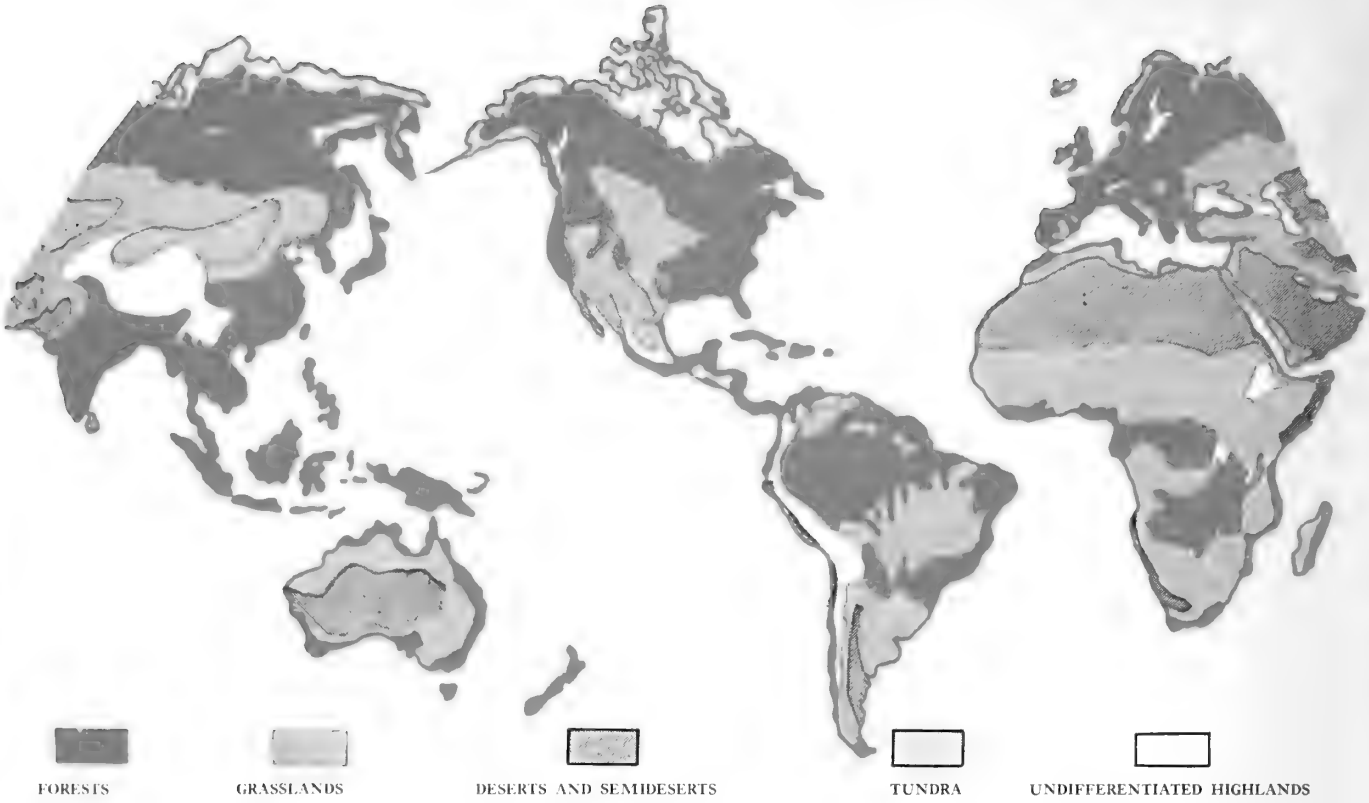


CAVE MAN AND THE WILD BOAR. (*From Obermaier's* Fossil Man in Spain)



A CAVE ARTIST TRIES his hand in sketching herds of galloping wild horses. A slab of stone from Cave of Chaffaud, France

After Cartailhac



GRAZING AREAS OF THE WORLD. Nomadic peoples frequented the margins between deserts and grasslands, where with expert handling, cattle, horses, sheep, and goats would fare well. Domestication only required substitution of herding for any habitual seasonal migration behavior the wild stock may have acquired. The pig did not thrive well in either desert or grasslands: forests, moist and even swampy, were his natural habitat. His range, in the Pleistocene, was from India to extreme western Europe, including the Fayum in North Africa

Habitual Associations between Man and Wild Animals

When people argue that it was natural for dogs and men to tolerate each other, they have in mind the differences that are obvious in the inborn behavior of the various other species of animals. For example, one reason for favoring the pig as one of the first wild animals to be tolerated in a camp or village is that in many parts of the primitive Old World, especially in New Guinea, the female pig with her litter moves freely about the village to feed upon offal and scraps of food discarded by the various households. The mother pig learns to look upon individual families as the source of regular "hand outs," and in turn her piglets are fondled by the children of the household and not infrequently allowed to feed from the breasts of the women. On the other hand, the adult boar is not tolerated in the village but banished to the surrounding bush, where he is hunted like other wild game. However, since the females

DRIVING DOMESTICATED PIGS to market: a scene among the Bontoc Igorots in the Philippine Islands. The distribution of the several wild species of swine was apparently almost world-wide, but domestication seems to have originated in Egypt and far-eastern Asia

THE REINDEER is not a strong animal but can carry a medium-size person or a light pack load. Lamoot Woman and daughter, Siberia

are not kept in pens but run about freely, the wild boars have no difficulty in meeting them at night or in the edge of the bush by day. In the village the pigs not only destroy accumulating garbage and filth but prey upon crawling and creeping creatures whose presence would be more than a mere nuisance. The natives not only recognize these services but, since the pig bears two litters a year, look upon the animal as a steady food supply. In the forested regions of western Europe hogs were herded while feeding on nuts and roots and in time were propagated for food and hides. Read the opening scene in Scott's *Ivanhoe* for an understanding of the economic importance of pig culture in Middle Age Europe. Even then boars seem to have run wild and been pursued by hunters, the head of the wild boar being regarded as the prize of the epicure.

Reverting to the dog, it is usually assumed that its wild ancestors, attracted by discarded food and the warmth of the campfire, gradually wormed their way into human society and rewarded those who tolerated them by detecting the approach of enemies and volunteering assistance in the hunt. Thus the association between dog and man could grow up naturally, the only surprise being that there is no trustworthy evidence for such mutual tolerance before the appearance of agriculture, about 10,000 years ago.

Wild cattle and reindeer were grazing animals, inclined to form relatively large herds and to seek tundra, grasslands, or park lands (open spaces in forested areas). Both are adapted to cool climates or seasonable habitats, in which they learn to migrate back and forth from north to south. The reindeer range farther north, even to the margins of glaciated areas, while cattle prefer the milder climates of the temperate zones where wet and dry seasons alternate. Reindeer roamed over middle Europe in glacial times, and since

CAMP OF NOMADIC KORYAKS, Siberia, with their domesticated herd of reindeer. The wall-tent in the center belongs to an American Museum of Natural History Expedition. The large tents are covered with reindeer skins, which with their poles and the baggage of their owners are transported by sleds drawn by trained reindeer

A.M.N.H. photo

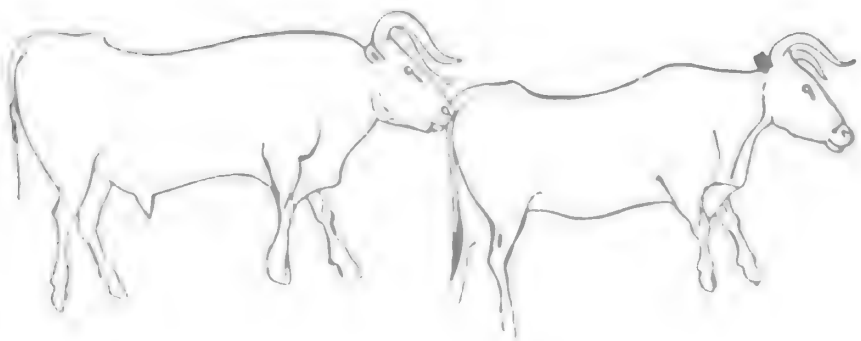
THE WILD ASS OF THE GOBI DESERT. The ancestors of the long-eared, heavy-muzzled, droll-visaged donkey ran wild in North Africa, a different species from the more horselike creature of the Gobi. Certain low-relief sculpture of the Sumerians show asses of the Gobi type harnessed to chariots, apparently valued for their speed, whereas the Egyptian artists depict the heavily-laden donkey, plodding beside his foot-going master

they still survive in wild herds in Arctic and sub-Arctic latitudes, we may assume that they shifted their range with the glacial cycles, northward in interglacial periods and southward in periods of advancing glaciers. No doubt the several species of man were troubled by these same cycles of cold weather. Four periods of alternating glaciation are accepted as having occurred during Pleistocene time. Post-Pleistocene time, in which we now find ourselves, may well be the fourth interglacial period, to be followed in the distant future by a fifth glaciation. Consistently enough, the earliest known man (*Homo modjokertensis*) appears in Java during the first interglacial period when the climate there was probably tropical, as at present. Middle Pleistocene time seems to begin with the second glaciation, and this is when man in China (*Homo sinanthropus*) began to use fire, probably with good reason.

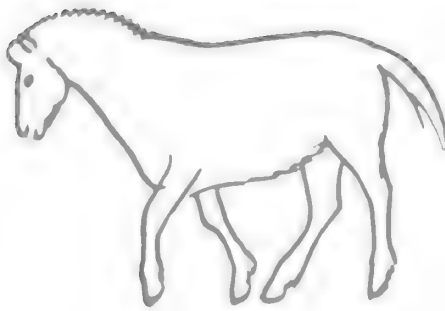
Whether reindeer were the first large grazing animals to be domesticated is not very important, and there is some reason to suppose that the date was much later than that for cattle. It is probable that cattle were among the first, but sheep may have preceded them, since at the famous archaeological site of Anau, Turkestan, bones of sheep were found beneath those of cattle. Some weight should be given to priority for sheep on the grounds that they are probably easier to control than either cattle or reindeer. But sheep were probably domesticated in one locality and cattle in another, so that it is difficult to prove which should be given priority in world chronology. Goats, also, may have preceded cattle, but the archaeological record seems to reveal no goat bones earlier than those of sheep or cattle.

Cattle, reindeer, and goats were milked, so we have no basis for deciding whether flesh or milk was the primary consideration. Asses and horses were milked too, but since it is assumed they were domesticated later than cattle, the use of their milk could have been suggested by cattle herders. In any case the first domesticated animals to be milked would suggest experiments with other domesticated species.

The chief interest in reindeer is that both wild and tame reindeer survive and that not



WILD CATTLE from Grotte de la Mairie, France. Horned cattle were widely distributed throughout Asia and Europe before the Age of Man. Good pictures of them appear in *Cave Art* after Capitan and Breuil



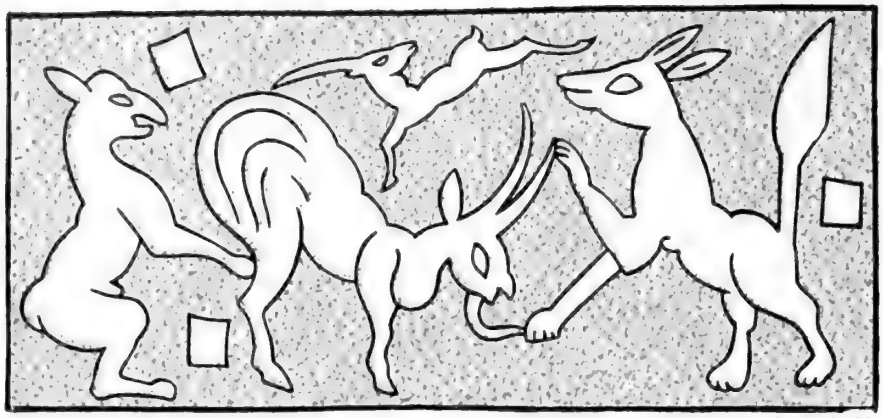
DRAWING OF A WILD HORSE from the walls of Font de Gaume, France, considered one of the finest examples of cave art

After Keith Henderson, in Prehistoric Man, *E. P. Dutton & Co.*

so long ago some Siberian tribes treated wild reindeer as game, killing them in the chase. At the same time, other tribes, recognizing that even wild reindeer moved in herds, shifted their camps with the migrating deer, taking care not to stampede the herd. Still others exercised some control by gently driving the herd to new pastures, protecting it somewhat against wolves and even against other hunters, thus naively conceiving ownership of a particular herd. At the other extreme is the complete control of the herd and the use of some individual animals for transportation, by saddle and sled, for milking, etc. It is not difficult to see here all the logically conceivable steps in the gradual domestication of the reindeer. The story for the domestication of cattle, horses, and other animals could have followed the same pattern.

Man's ability to provide protection for animals and supply food in times of scarcity puts the herded animals in his power. For example, the winter-feeding of elk in our National Parks tends to hold them to the feeding ground; the herd will stay around the spot and starve rather than migrate to fresh pastures. When mounted herders drive them to new grounds where feed is abundant, the homing instinct of these erstwhile wild elk brings them back to the feeding place, where they will die of hunger if not fed, failing to remember the places where pasturage was plentiful. It would seem that in providing winter food for a single season wild elk were essentially domesticated and rendered incapable of survival. If they had been herded on the new range for the season and then returned to their former feeding ground and this process continued year after year, we should regard them as domesticated. After all, there is nothing very mysterious

THE PRZEWALSKY HORSE OF ASIA, assumed to be a descendant of the wild horse of Stone Age France, depicted above



AN ANCIENT CARTOON for a "bedtime story," showing foxes milking a goat, suggesting that people of the time milked goats from behind. We note further that the concept of the fox as a trickster is ancient, perhaps handed down from the Old Stone Age. The original drawing was found at Ur

After Leon Legrain, The Univ. of Penna. Museum Journal, 1924

here: we mention it to clarify our understanding of what may have been a natural process.

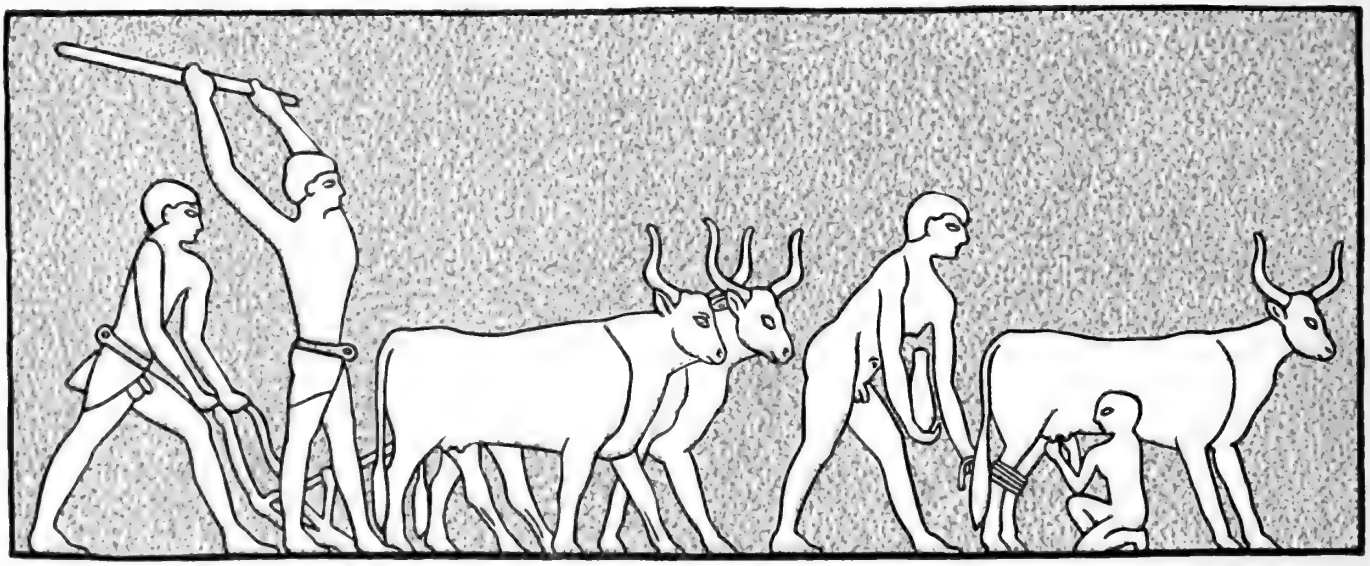
Tribes specializing in the control of flocks and herds but making no attempt at agriculture, are usually characterized as nomads or pastoral peoples. Some years ago there was a favorite theory that, in the evolution of society, hunters passed first from hunting to herding and later took up farming. This can be made plausible, but it is now realized that the environment determined where herding and agriculture could best be developed and that the first great civilizations were brought about by a combination of stock raising and agriculture. We have previously suggested that the most favorable locations for such an integration were the narrow valleys of rivers coursing through deserts, as the Nile, Euphrates, and Indus, where, during the rainy season, herds could be pastured upon the adjoining desert lands and brought back to the marshes and deltas for winter feeding.

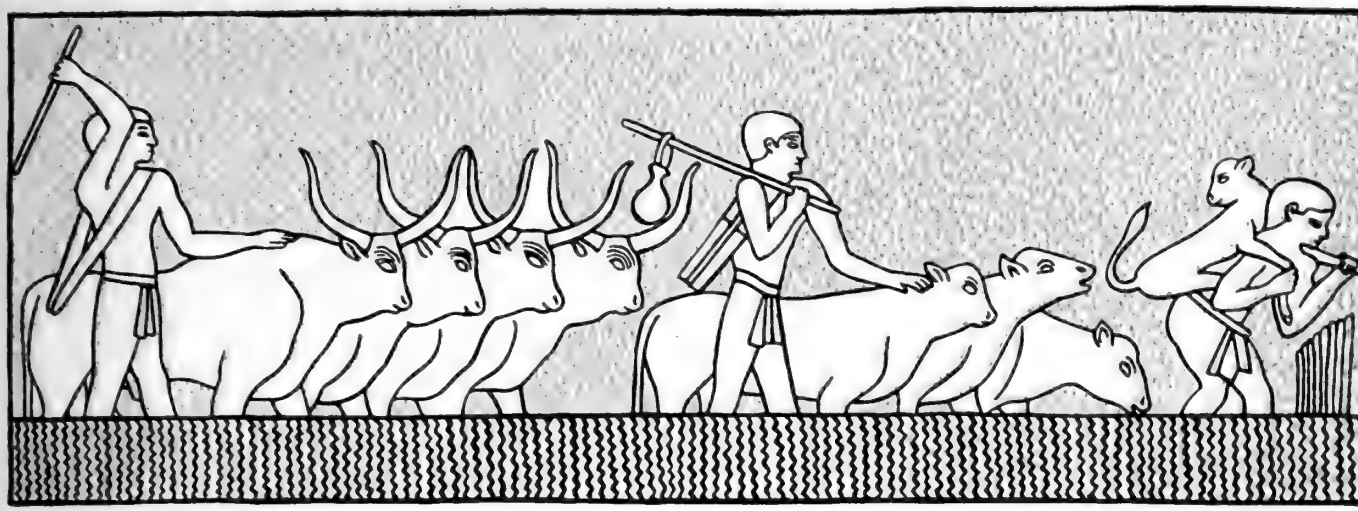
As in the case of plants, man soon learned that selective breeding could rapidly change the body build and the behavior of his live stock, if mating were rigidly controlled. Sheep wool is so different from that of surviving wild sheep that its origin is considered to be due to man's care in breeding. In western Canada the Indians even bred a strain of dog with white wooly hair, excellent for spinning. They also spun the hair of the local wild goat but without domesticating him. The hair of surviving wild sheep in North America is too smooth to be practical. In Peru, the hair of llama, alpaca, and vicuña was used to spin yarns, usually for the warp in cotton fabrics.

In conclusion, it is by no means clear whether the larger share of credit for the domestication of animals can be justly claimed by man. The behavior patterns of the animals to be domesticated may have been the first cause, and the long delay on the part of man may have been due to his own predatory habits, which automatically classed him with the larger carnivorous animals. That man made little effort to domesticate tigers and lions is clearly logical; and in a region where

EGYPTIANS milked from the right side. Cow's legs were tied to protect the milker. 28th century B. C.

After V. Gordon Childe, Man Makes Himself





After Breasted, The History of Egyp

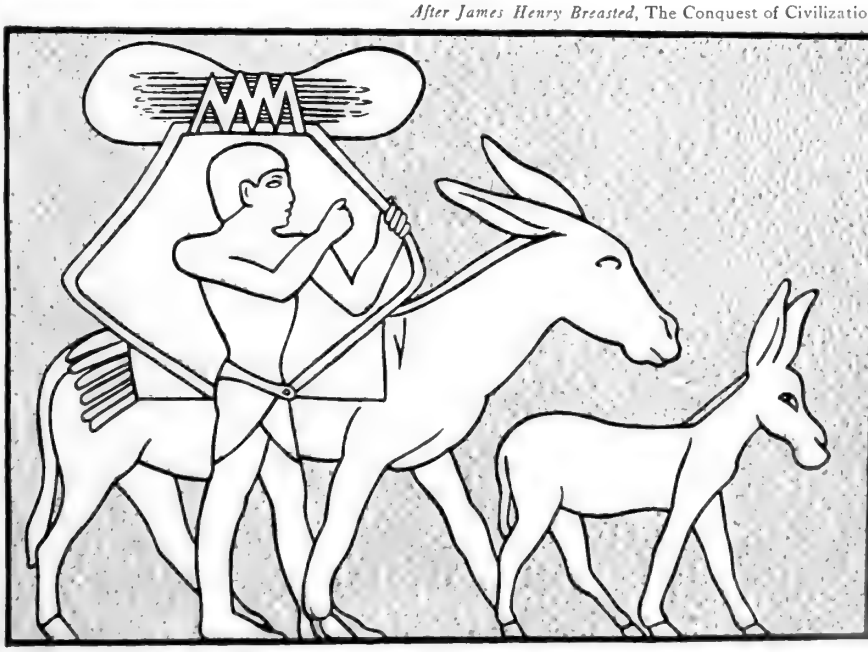
CATTLE CROSSING A CANAL. Two breeds of cattle appear in this scene, horned and hornless. Note the calf carried before its mother to lead the herd. The Egyptians took pride in their cattle, often showing herds on the march and in stables. The animals were used for draft, milk, and beef. The domestication of cattle may have preceded agriculture. In our alphabet, "A" is of ancient origin, derived from the picture of an ox head, inverted. Date of drawing about 3000 B. C.

people lived by hunting it is far from obvious that herds of relatively defenseless animals should seek food and protection around the camp.

Yet there are suggestions that when hunters came to be in part farmers and their food crops lured grazing and root-eating animals to the villages, the villagers would be prompted to adopt one of two expedients in defense of their own food supply—driving the herd away or leading it to pastures farther afield and holding them there. Thus automatically and without thought on the part of anyone, a habitual relationship between the herd and the village would evolve and perpetuate itself. Later, some speculative sage would make an original contribution to social belief by remarking that the herd was now community property. Note that the relationship between the herd and the village first came to be a reality; only later was *thought* applied to it, giving expression to the relationship in words and finally causing it to be taken for granted.

The part that the much vaunted "human intelligence" played in the achievement seems to fade into obscurity. The herders may have been as blind to the initial steps in domestication as were the herded. Why, then, should we be astonished when told that some ant colonies keep herds of "milk-giving insects?" Probably because we consider man very intelligent but look upon the ants as devoid of that quality.

After James Henry Breasted, The Conquest of Civilizatio



THE DONKEY was the primary beast of burden and everywhere preceded the horse. Women and children rode it, men walked. Egyptian drawing, Pyramid Age

Inventions During the Long Pre-Civilization Period

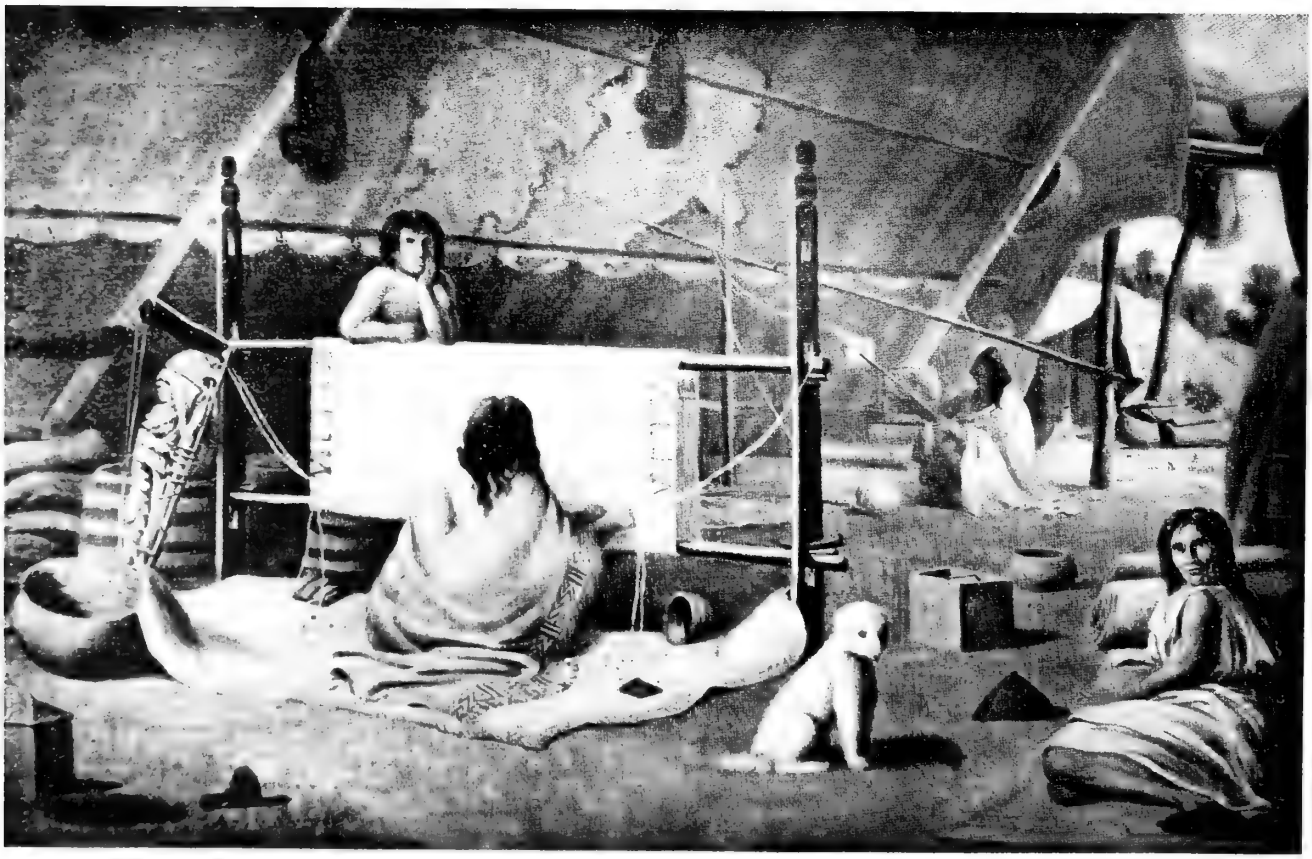
A final perspective may be gained by attempting a resume of the evidence that the beginning of plant and animal domestication was the primary stimulus to his culture evolution.

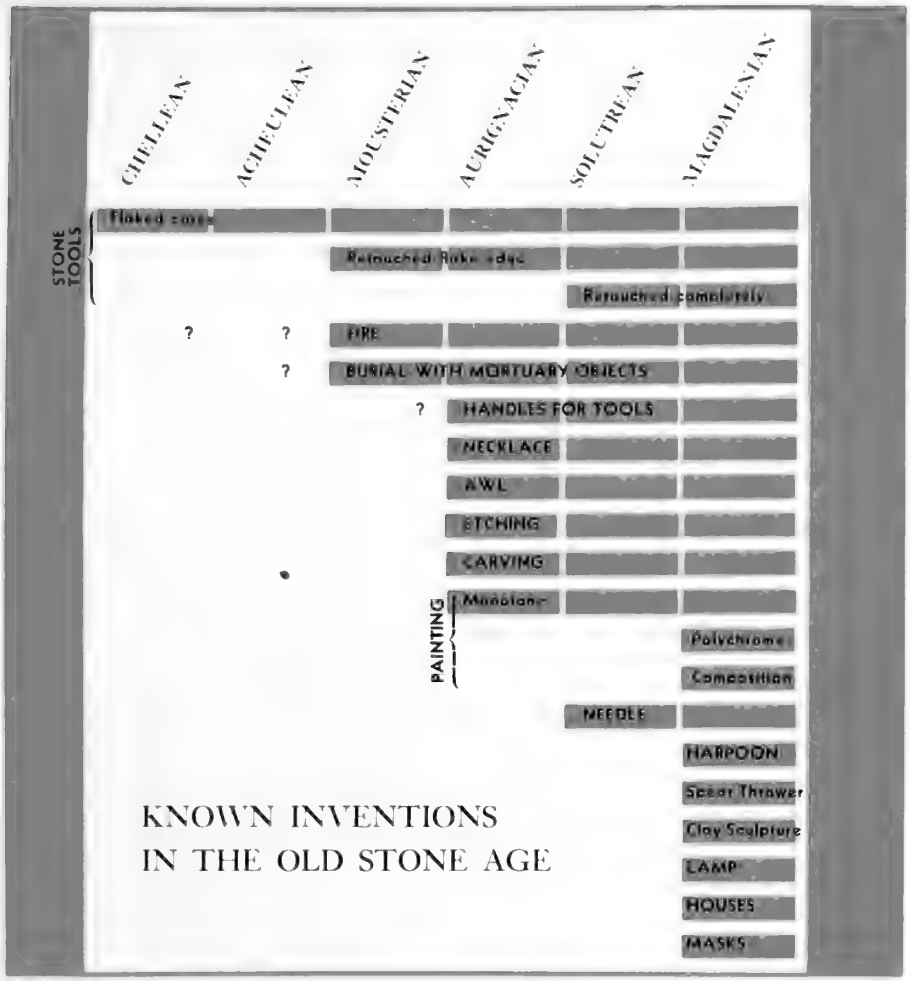
We should not overlook the important fact that man was a speaking, thinking inventor for several hundred thousand years before the relatively recent civilization boom. Fire was probably his first great invention. Inventing a handle for the stone axe was another great step. Twisting string was another. Then the inventions of art—line drawing, sculpture, clay modeling, color painting, perspective, and composition—all appear before civilization. The invention of needles in Solutrean time tells of another great step. Again the burial of the dead with mortuary offerings proves that early man was by no means slow in constructing a religious philosophy. The chart we give for outstanding inventions during the Stone Age speaks for itself. It reveals part of the preparation man had made for the rapid, astonishing speed of achievement in civilization when the release came.

As a nomadic hunter man could never grow numerically strong. Even with the best possible social organization, camps of hunters must be small and scattered. Critical studies of living conditions among surviving savages gives no ground for believing that the population of the world under a purely hunting and gathering economy could have been large. The approximate land area of the world is 50,000,000 square miles; the estimated land needed per capita to support a hunting population is seven to ten square miles. Then in round numbers the expected primitive population of the world in 7000 B. C. would not exceed 7,000,000—about the population of New York City.

Yet we know that cities of moderate size accompanied the rise of civilization and that achievements of civilization would have been impossible without local concentration of thousands of adult human beings.

A British Columbia Indian weaving a blanket of yarn spun from the wool of the white dog shown at her right. These dogs, bred and sheared for their wool, became extinct soon after white contact





A Possible Explanation

The reader may still be perplexed as to why it was just here in these deltas and narrow river valleys in the midst of deserts that civilization happened. The answer may be that these were the most favorable places. As local environments they were very much alike. What we do know is that these rivers flooded regularly once a year, that the people found it easy to grow cereals there, that cattle, donkeys, swine, sheep, and goats were in the country. We expect these animals would crowd into the fine feeding grounds of the deltas at least at the times of the year when the pasture on the arid uplands was thinnest. When man was forced to seek refuge in the same place, he found the animals in possession. Wild animals, wild plants, wild men, all predatorily inclined, crowded into the same narrow river valleys, and, not unlike flood victims on a raft, were forced by necessity to adopt a more economical use of space. Man's type of behavior was best able to cope with this new situation. He may never have faced the like of it before, but if so, he had failed. As a hunter with several hundred thousand years of experience with animals, he knew how to fight off the lions and other carnivores to protect the peacefully inclined ruminants. Nature herself gave yearly demonstrations of planting crops of grasses and of irrigating the marginal dry lands. So man could begin to co-operate with the herbivorous animals and to exploit plants. Because of increasing food supply, his own numbers increased geometrically, cities arose, herds multiplied, and cereals improved.

The many pictures of kings killing lions, wild cattle, etc., may not be just sport but symbolic of man's war against the wild animals from without that menaced the increase of his tame herds and threatened his growing crops. Also there were envious

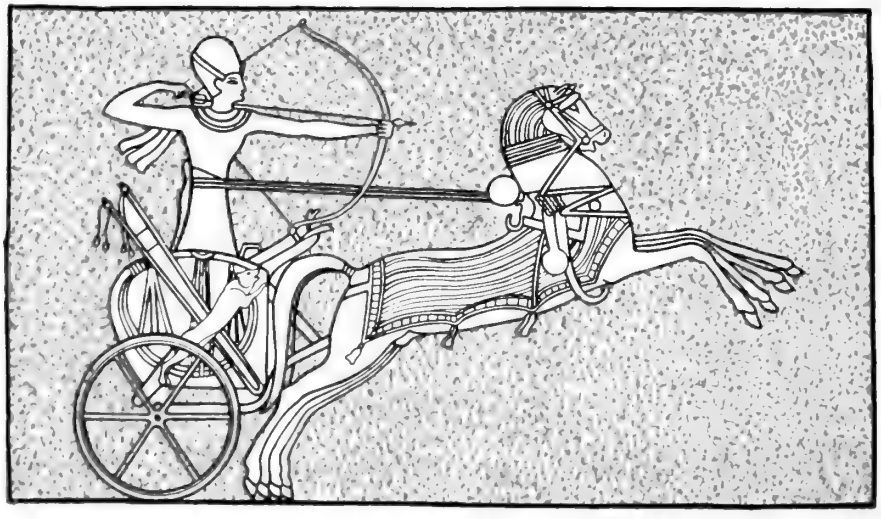
THE AZTEC AND INCA CITY STATES OF 1492

nomadic hunters on the outskirts, learning to be farmers and herders by imitation, ready to raid and dispossess the civilized of their rich lands, herds, and cities. New blood and abilities were ready to displace the old to carry on to greater achievements.

Most of this is speculation, but whatever the causes, it did happen. Once man sensed that he could by self-discipline produce more and more food and comfort, a few centuries would suffice to rear mighty cities and great civilizations. Significant changes in the ways of living would follow within a single generation.

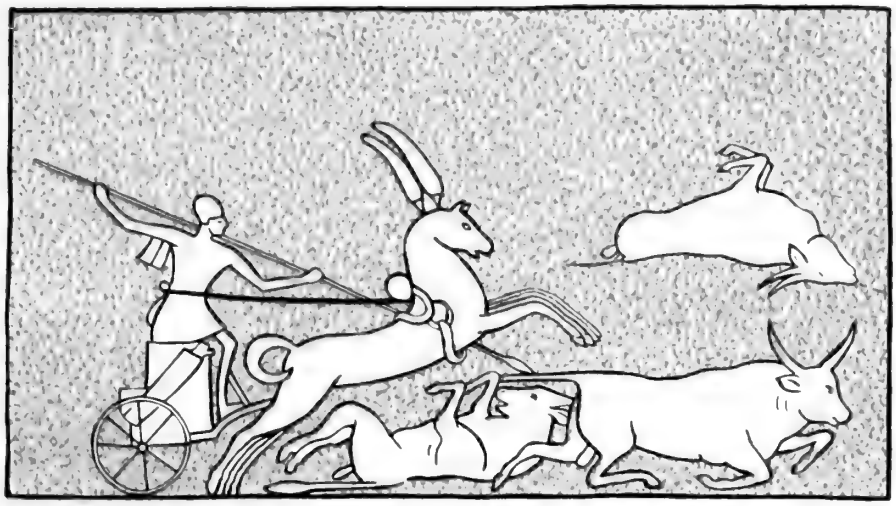
Yet at the outset the ages-old nomadic hunters might need something more than the shock of a strange environment to break old habits; at least nature was kind enough to offer yearly demonstrations in sowing and irrigating. We shall never know, but the facts we have hastily reviewed offer some hints as to how it may have been that civilization arose around these river deltas as revolutions in living. The explanation may lie in the commonplace circumstance that for part of the year man could graze his herds upon the dry lands marginal to the rivers, while producing enough grain and hay along the borders of the river to stable-feed the animals when pastures failed seasonally. What we call civilization may be little more than wise integration of farming and animal husbandry.

THE Spanish explorers following closely on the heels of Columbus found two large political units in the Americas, the Aztec regime in Mexico and the Inca in Peru. The relative extents of these so-called empires are shown on the map. Many books have been written seeking to prove that these were not empires like those of the Spain, France, and England of 1492, which is true; Aztec- and Inca-land were different because they were not modern but reminiscent of Egypt, Ur, and Indus of early days. They were city-states and had evolved along lines generally parallel to the Old World city-states just mentioned. The two outstanding seats of power were the Aztec City of Mexico and the Inca City of Cuzco. Between and surrounding these two



EGYPTIAN WAR CHARIOT. Well trained horses were guided chiefly by words, but usually by a separate driver. The chariot spread to Europe and was used effectively by the ancient Britons in wars against the Romans

After James Henry Breasted, Ancient Times



THE EGYPTIAN King Ramses III, hunting wild oxen in the delta marshes of the Nile. In the Euphrates country, hunters speared lions from chariots and sometimes from horseback

After James Henry Breasted, A History of Egypt

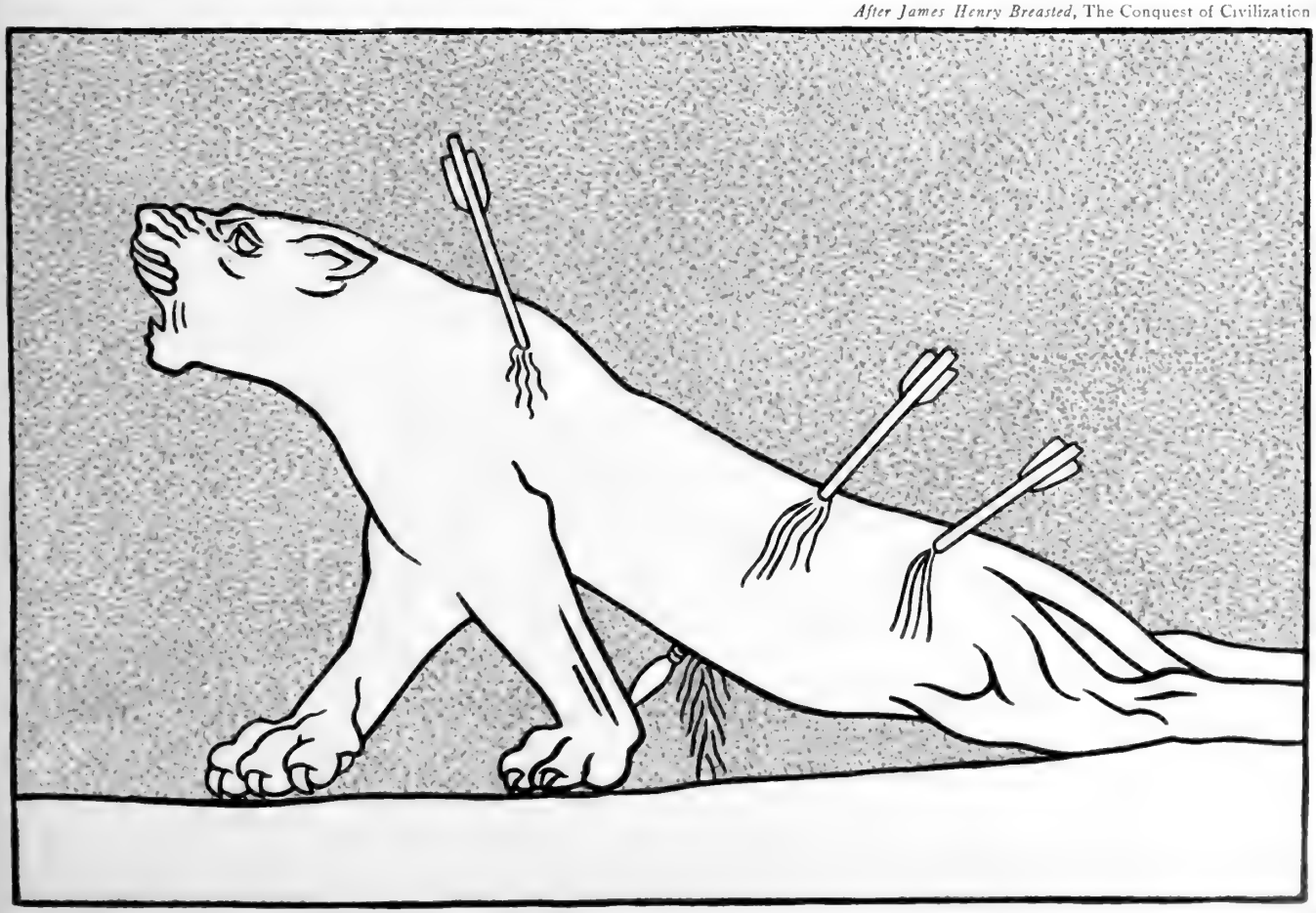
dominant nations were smaller city-states.

The Old World city-state pattern of empire began with Ur and ended with Rome, after which the Dark Ages of the barbarians prevailed, to emerge eventually through feudalism into the Christian type of empire of which the Spain of 1492 was a good example. The Aztecs and Incas, on the other hand, were yet evolving a stone and bronze age type of city-state civilization. This is why the favorite way to characterize these American aboriginals in 1492 is to say that they were engaged in an evolution of civilization, in a way parallel to what had happened in the Old World, but about 2000 years behind schedule.

We gained an insight into Old World civilization by noting that its distinctive characteristics were cereals and animal husbandry. Everywhere and even now among the heirs of these Old World civilizations wheat is the chief cereal. We shall find it equally important to recognize that the basis of aboriginal New World civilizations was

ONE OF THE FINEST sculptures in low relief depicts a wounded lion struck by arrows and paralyzed by a punctured spine. Ancient peoples hunted probably not just for sport but to protect their herds

After James Henry Breasted, The Conquest of Civilization



Outstanding Traits in Old and New World Civilizations

Old World	New World
Cereals (wheat, barley, etc.)	Cereals (types of maize)
Domesticated animals (cattle, horses, asses, sheep, swine, dogs, poultry, bees, etc.)	Domestic animals (turkey, guinea pig, llama, dog, bees, etc.)
Plow (drawn by man, later by cattle)	Digging stick (foot plow and hoe)
Wheel (cart, hand mill, potter's wheel, etc.)	No wheel (human packing, metate, hand shaped pottery)
Cities, aqueducts, and irrigation systems	Cities, aqueducts, and irrigation systems
Temples and state religious systems	Temples and state religious systems
Metals (gold, silver, copper, and bronze)	Metals (gold, silver, copper, and bronze)
Special hand crafts (as in stone, wood, textiles, etc.)	Special hand crafts (as in stone, wood, textiles, etc.)
Writing (wax and clay tablets, paper, inscriptions on stone)	Writing (paper, the quipu, inscriptions on stone)
Slavery and regimentation of labor	Slavery and regimentation of labor
Tribute, or taxes, imposed upon subjected cities	Tribute, or taxes, imposed upon subjected cities
State ownership of resources and land	State ownership of resources and land
State highway systems	State highway systems
Freight by ox cart, rapid transit by horses	Freight by human carriers and llamas, relay human runners, suspension bridges

THE OLD-WORLD WAY of grinding grain is the hand mill. It goes back to Ur, Egypt, and ancient times generally, and is still seen in Oriental and Mediterranean countries. The advantage of the revolving principle is that power can be applied. First, hand power was used, then draft animals, water, wind, steam, etc.

the group of cereals designated as maize (corn), accompanied by a weakly developed animal husbandry. Herein lies the chief contrast. We can now see the significance of our previous statement that Old World civilization is based upon a well integrated, nicely balanced economy of cereals and animal husbandry.

The Pattern of New World Civilizations

We found it useful to characterize Old World civilizations by enumerating fundamental traits defining a pattern in their then new way of living. It may be doubly illuminating to tabulate in parallel columns the traits most distinctive of the Old World civilizations as compared with those defining the character of New World civilizations, as in the accompanying table.

Close parallelism seems to dominate these two patterns, but certain differences are conspicuous. Thus in the New World there is neither the wheel nor its common applications in the cart, pottery wheel, and rotating hand mill. The metate, a flat slightly concave stone, is the New World device for crushing cereals for meal or flour. Secondly, neither cattle, horses, sheep, nor swine were known. Instead of the time-honored plow, the New World used the simple digging stick, with its more specialized form, the spade, or foot-plow. In other respects the two world patterns are remarkably similar. Yet what a gap these few exceptions leave in the profile of American aboriginal civilizations. To their Spanish conquerors the Aztec and Incas seemed contemptible—no cannon, no steel weapons, no metal armor, no horses, no oxen, no carts, man power only.

THE NEW-WORLD DEVICE for grinding grain: the metate. It is still in use in the United States, Mexico, Central and South America, and the West Indies. The grain is crushed between two stones by pressure. The principle of the revolving wheel was not recognized in the New World, hence the circular mill was unknown

Drawings by Paula Hutchison

Summary Comment

THE foregoing pages are presented as a brief digest of the available information about the important cereal and animal foods, the external universal pattern for mankind, "bread and meat." To save space and time the details are presented in outline form, hoping the reader may be able to sense their significance in perspective. Ever since man became conscious of the world as a whole he rarely fails to be moved by any realistic presentation of human experience in time and global space.

Another point of interest to us is that so far as is known the élite of the Aztec and Inca possessed some knowledge of the barbarian tribes on their respective frontiers but were wholly unconscious of an Old World and the achievements of its inhabitants. The possibility of such an entity as another hemisphere had not occurred to them. Small wonder is it that the appearance of Europeans with unheard-of weapons, ships, and horses, with a background of learning and insight incomparably more acute than they had ever experienced, rendered them incapable of any effective resistance.

Something more than a hundred thousand years of striving and thinking have gone into the making of this story of the homely routine of never ending daily chores which few families have ever been able to escape. We hope their direct recital may cast some glint of romance and inspiration over all. If the reader should find inspiration and insight herein and note the great gaps in existing knowledge of the subject, he can glimpse the grandeur of a similar synthesis some decades hence when anthropology, archaeology, paleobotany and paleontology have delved deeper into the past. Though scarcely two centuries old these sciences have revolutionized man's attitude toward life and his thinking. Not all his experiences for a hundred thousand years so radically changed his outlook.

Equally moving handbooks could be written on fiber plants (hemp, nettle, flax, cotton, etc.). Some recent archaeological studies have suggested that the cucurbits (gourds, calabashes, cucumbers, pumpkins, squashes, etc.) as a promising subject for research. The world wide history of the bean is another possibility. Finally the familiar potato which holds so secure a position in modern world diet furnishes material for a fascinating story.

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Th
LIFE
WATER

➤ A WATER STRIDER rows dry-shod over the surface of the pond. The depressions in the film under each foot show strained irregularities

The LIFE of the WATER FILM

The lives of many small animals and plants depend upon the fact that water is not always wet

By LORUS J. MILNE *and* MARGERY J. MILNE

All photographs by the authors

ONE of the first facts learned by every child is that "water is wet." In more mature years this wetness is so taken for granted that any exceptions to the rule arouse great interest. Thus the sewing needle that can be lowered gently onto the surface of a tumblerful of water, there to float completely dry, is a startling discovery. Yet to a large number of different animals and plants, this problem of wetness and dryness is a matter of life and death. Many of them find the "dry" surface of water to be a place to live, albeit precariously. Suspended between the air above and the depths below, they inhabit the surface film of ponds, streams, lakes, and even oceans. Theirs is an almost two-dimensional realm, a special niche in nature for use of which certain requirements must be met.

When a substance attracts water molecules more strongly than water molecules attract each other, the water wets the surface. The liquid creeps along, invading every crevice, clinging tightly to each irregularity. But some materials, such as waxes and oils, attract water molecules so little that the water draws away, pulling back into itself and leaving the surfaces dry. Aquatic birds take advantage of this principle by regularly adding oil to their outer plumage, thereby keeping their feathers from becoming water-soaked. The many creatures that walk on water do so by means of well-waxed, hair-booted feet which the water cannot wet.

Best known of all the animals that walk dry-shod on ponds and streams are the water striders,—bugs with four long legs stretching out to the sides and a shorter pair held under the head. Their slender feet are covered with greasy hairs which the water fails to penetrate. Each foot presses the water surface and makes a dimple in it, but the water does not run around and let the foot fall through the surface film as it would if the waxy hairs were absent. Instead the insect's weight is supported partly by the buoyant force of the water displaced from the dimples and partly by the surface tension which tends to erase the depressions and bring all the water film to the same level. The strider uses chiefly its hind- and foremost legs to hold its body well above the smooth and slippery surface of the pond, while working the middle pair as oars to scull itself along. Mirrored in the water film below the bug is its image,—a reflected "double" seldom seen except by small creatures close to the water surface. Below the strider, on the bottom, are dark shadows cast not only by the insect, but also by the dimples in the surface film where its feet press downward. Sometimes, on sunny days, these shadows on a sandy bottom are more conspicuous than the insects themselves. They drift along and follow every movement of the rowing striders on the film above.

➤ A QUIET POND provides the naturalist with an excellent opportunity to study the life of the water film

A considerable *length* of surface must be called upon to support an insect as heavy as a full-grown water strider. If its hair-booted feet pressed on the film at only six small points, the bug would penetrate into the water and sink at once. But the strider's legs are spread so widely that its feet make elongated dimples or furrows in the water film. So secure is the insect on a quiet pond or stream that it can shift its weight freely among its feet. Most spectacular are the demonstrations of this when a strider cleans itself. Drawing its rowing legs far back, it stands with its head almost in the water, while its hind legs are raised well above the surface and rubbed one against the other much as the housefly does. Then the insect rests on forefeet and one hind foot, with the rowing leg on that side as an outrigger, while the middle and rear feet of the opposite side are raised into the air and rubbed free of clinging particles by a similar fiddling movement. To accomplish this contortion, the bug practically lies down on its side. The water film stands the strain, but the shadows cast on the bottom shift and spread as the pressures on the fewer surface furrows are increased. Finally the strider stands on rowing feet and rear pontoons while its body and forelegs are raised high above the water. The insect washes itself much as a kitten does, transferring dust particles from feelers, beak, and body to the forefeet, then rubbing these together until they are satisfactorily clean. The bug seems to give great care to every detail, and if uninterrupted, such a complete toilet operation may take ten minutes.

The Quest for Food

Other animals that spread their weight on outstretched feet can rest with safety on the water film. Small gnats and midges flit from place to place on ponds, alighting with equal equanimity on film or foliage. Even large crane flies settle with surprising grace upon the water surface, and rise again with their long legs trailing behind. Each foot combines the advantages of waxed hair covering and slender length which can distribute the insect's weight along the surface film. Sometimes the water striders catch small flies that fail to take flight in time. Occasionally, too, a crane fly dies of unknown causes while resting on the water surface. Without muscle action to hold its body well above the water, the insect sags into the pond and sinks in or barely stays afloat. Water striders gather around it to salvage such nourishing juices as remain. It is but one of the many types of food the striders seek as they push their way along the transparent but rubbery surface film. Some of their sustenance floats up to them from below; each dead fish attracts a crowd of striders. But most of the food of these insects falls into the water from the air above. Ants tumble from leaves overhanging the water. Beetles close their wings and drop or blunder into ponds and streams where the water wets them and renders them helpless prey to the predaceous bugs. The striders investigate every particle, often making great leaps over the water to reach some newly fallen object. Small particles such as drowning ants are picked out of the surface film and held on a slender black beak while

▲ EACH STRIDER has a "double," mirrored by the surface of the water

◀ TWO STRIDERS approaching the cast skin of a *Dolomedes* spider. One strider carries an ant around on its slender beak while removing the nourishing juices. Only the under surfaces of the ant and the spider's "ghost" are wet

the life juices are drained away. Often a strider is seen carrying with it a gnat or other carcass as it glides along the water surface. Occasionally other striders chase the food-bearing relative across the pond, just as chickens pursue a hen fortunate enough to have found a large grub.

On ponds and streams the striders stay close to shore or hurry to reach it if a breeze springs up and the water's surface becomes ruffled. In rain and in winter, the striders leave the water and crawl out upon the bank. In spite of these precautions, the insects do get wet at times. Although they show great ability in navigating streams, and can spring ahead to make progress against the current, an occasional bug is swept through a riffle and fails to stay afloat. In such situations, striders may be found below the surface film, rowing to shore where they can crawl out again to dry and clean themselves.

Seagoing Striders

There is also a seagoing water strider,—a small gray form common in tropical and subtropical lagoons and mangrove swamps, where it congregates in large groups. These same water striders are found at great distances from land, riding the waves like the best sailors. No one knows what they do during a storm at sea or when it rains. They must get wet, and what is there to crawl out upon to dry? To add to the problem, these seagoing striders often crawl down into the water during calm weather, and row along to feed there, upside down, on the underside of the water film. Many of them live out their lives hundreds of miles from shore and raise their families at sea. The eggs are laid on seaweed at the surface of the ocean or on the infrequent feathers dropped by sea gulls.

Spiders and mites of several kinds frequent the water film in pursuit of the insects there. They have the same means of staying dry as do the striders, and they scamper about on ponds picking up food wherever they can find it. Most of the water spiders are tan with dark stripes. Many of the females lay their eggs in a creamy sphere of silk, and drag this precious ball after them wherever they go, even out upon the water film. One of these ball-making spiders is a giant called *Dolomedes*. A full-grown mother may measure two inches or more between the tips of outstretched legs; her egg sphere may be half an inch in diameter and contain hundreds of potential spiders. Even after they hatch, the spiderlets stay with their parent, and the adult is often seen with a fuzzy covering which can scurry off, like goslings from a mother goose. Such a family group is quite a prize for a hungry fish, and those spiders that hesitate while running on the water film may lose their lives. However, spiders seldom stop on the surface; they run from shore to plant or from leaf to lily pad, carrying their prey with them to a safe spot. But fish in ponds and streams follow walkers on the water to profit from their occasional unwariness. Sometimes a fish makes a mistake and seizes a spider's ghost,—the empty, castoff skin. Often these skins float downstream, casting on the bottom a shadow much like that of the spider itself. But the skin rests on the water like a dead crane fly, while the living spider walks well above the surface with only its eight feet furrowing the film and making sharp silhouettes on the sand below.

Most conspicuous of the water mites is a common one with a ball-like body of brilliant, velvety red. The full-grown mites reach a diameter of a quarter of an inch. They run so smoothly on their very short legs that they seem to glide over the surface film rather than move on distinct feet. The females leave solitary brown eggs on floating vegetation, to hatch into immature mites with six legs instead of the characteristic eight. These larval mites spend a few weeks as parasites on some insect. They lie in wait for water striders or diving beetles,—anything that comes their way. Sometimes they ride on damsel flies; more often they catch the striders. One strider may carry several of these clinging mites, each sucking nourishment yet seeming to do little harm to its host. Eventually they drop off, molt to gain another pair of legs and the spherical form of the adult body, and forage for themselves as their parents do. The mites not only run along the surface, but frequently climb down plant stems into the water and swim about. Their eight short legs give them an even motion by which they may be distinguished easily from all other aquatic animals.

Catapult Take-off

Very small insects with waxy feet can stand upon the water film without the additional precaution of spreading their legs widely. The smallest mites have this advantage. So do the several kinds of springtails and the many leaf hoppers which jump over the surface. These animals are so very light that even when they press down sharply on the water film to throw themselves into the air and escape some danger, they do not produce any sizable dimple in the surface. The leaf hoppers have leaping legs like a locust's or a katydid's, but the springtails have a much more ingenious way of catapulting them-

▲ THESE WHITE, TRANSLUCENT AQUATIC LARVAE of a fly can continue to breathe while the front end works through the bottom ooze of a shallow pond for food. Each has a cup-shaped cavity at the posterior end open to the air, exposing spiracles (black paired marks). Through these, gas is admitted to white tubes which extend through the body. The creatures are less than half an inch long

▼ THIS MOSQUITO WRIGGLER hangs from the surface film by a whorl of waxy hairs around the opening of its breathing tube

selves into the air. They are grotesque insects, with an extended tail. Some merely keep this tail curved under them, almost resting on the water film between their six short legs. To jump they simply straighten out, but do so suddenly. Others carry the tip of the underturned tail in a special catch, like the notched trigger of a mousetrap. The tail is strained against the catch just as is the mousetrap spring. When the insect is frightened (or sometimes seemingly just for fun) the catch is slipped, the tail whacks the water film, and the springtail is thrown high into the air, to land somewhere else. For a creature so minute, air has an excellent cushioning effect, so that the springtail settles without damage, usually on its feet.

Two types of springtails are common on fresh water and one on quiet bays of the ocean. The more abundant of the lake and pond forms is bluish black, about an eighth of an inch long. It congregates in such enormous numbers as to appear as a conspicuous blue-black band along the water's edge. The individuals walk about among their fellows, but at the slightest disturbance, the group flings itself into the air like tiny corn kernels popping on a hot griddle. They alight many inches away, no longer in association with each other. To all intents and purposes they have vanished. Like other springtails, these have a tubular extension from the underside near the catch for the springing organ. With this "ventral tube" they are able to hold themselves to the water surface. The tube can be wet by the water and forms a sort of anchor for the insect. The seagoing springtail and the seagoing strider are among the relatively few insects that are not bound to a land or fresh-water existence. The seagoing springtail is found all over the world along sandy and muddy coasts and on tidal pools in rocky shore lines. No one knows what happens to them during storms and showers at sea. Not all of them can come ashore for such occasions.

Beneath the Film

The underside of the water surface is also used by a surprising number of aquatic creatures. Every now and again a pond snail crawls up a plant stem as far as the water surface, there to roll over and glide out under the water film, its flat foot pulsing with slow waves of movement from aft to fore along its length. In this position, many of the snails apply to the water surface a part of the body between foot and shell, and there open up the single hole that leads into the lung, so they can breathe in a load of air to take below. In very shallow water, a flat sole similar to that of

the pond snail, but much smaller, shorter, and narrower, turns out to belong to a worm which is all sole, with almost no thickness. This flat-worm, a free-living scavenger related to the liver flukes and tapeworms, is commonly called a "planarian" and seemingly has crossed eyes spotted on its speckled back. It is a source of never-ending delight to all biology students, and a laboratory pet with a firm grip on life. The animal is so elementally constructed that pieces cut from a single planarian can reorganize to form a whole. Biologists have worried out the philosophies of "self" in terms of many-headed, several-tailed planarians, which creep along the sides and water surface in laboratory jars to mock their captors.

Hydra

Another animal capable of remarkable regeneration is *Hydra*, named two centuries ago by a man who, discovering that it could multiply heads if mutilated, thought of the Greek mythical monster of that name. *Hydra* looks like a discarded umbrella without any cloth covering,—merely a stalk with long arms from one end. The arms are tentacles with nettling cells for catching microscopic life, and between the arms is an opening into the animal's interior, through which the prey is thrust for digestion. The opposite end of the stalk is armed with a sticky disk, the stickiness of which is under the creature's control. Often *Hydra* reaches a few of its tentacles upward and attaches them to some plant stem, then lets go with the sticky disk, to somersault in slow motion and glue its body to a higher point. Repetition of this process or a gradual gliding of the sticky disk may bring the animal almost to the water's surface. There *Hydra* often hangs, foot stuck to the underside of the water film, body pendant, tentacles outstretched for an inch or two beyond, waiting for unwary water animals to bump into its battery of stinging cells. *Hydra's* weight upon the water surface forms a dimple there, but the depression is not like the furrow under the water strider's foot. It is more similar to that around the snail or flatworm, and *Hydra* can creep along the water as they do, although with no visible waves of movement. These submerged creatures produce a water-repelling material from the flat area applied to the surface film. The water draws away, clinging wetly

▼ Pond snails in a shallow puddle. The one with the black spotted shell is on the bottom of the puddle, while the other crawls under the surface film. This photograph, like others in the article, was taken with a Bausch and Lomb Tessar lens treated with Balcote to reduce the flare

only to the rim of *Hydra's* disk or of the soles of snail or worm.

Two types of minute crustaceans upon which *Hydra* feeds have odd relationships to the underside of the water film. One of these, *Scapholeberis*, by name, has special waxy bristles with which to puncture the water film from below and lay hold upon it. Since these bristles are on the underside of the crustacean, the creature rests back downward, supported by the film. For purposes of camouflage its body coloring is related obviously to its upside-down position, for instead of being dark-backed and light-bellied like fish and most other animals, *Scapholeberis* is the opposite. In this position, the crustacean rows itself about with its long antennae, browsing on algae that float upward from below, and upon pollen and other flotsam accumulated on the water surface from the air above. A gust of wind tows the surface water and *Scapholeberis* attached to it,—a "sort of submarine sailing" some have aptly called it.

The other type of crustacean is typified by *Bosmina*, a tiny creature which is often trapped by accidently breaking through the water film as it swims along below the surface. Unless a wave or similar disturbance knocks the helpless creature below the film again, it must wait in this position—partly in and partly out of the water—until it can molt its skin and slip out of the old covering into the lake below. The difficulties encountered when a small underwater animal is caught by the "dry" surface of water are similar to those experienced by animals of similar bulk and strength when they fall into the water from the air. Unless a branch is near by upon which they can crawl out, they usually drown or are picked up by water striders and other carnivorous creatures that make this two-dimensional world their home. Even water striders have difficulties; readers of Frank E. Lutz' fieldbook are cautioned to carry home their striders in a dry pail, not in water, lest they drown.

The many insects that live in ponds and streams must have atmospheric air to breathe, and remarkable provisions have been made for reaching through the surface film.

Back swimmers, mosquito wrigglers, diving beetles, and other water beetles come to the surface from time to time to thrust through the water film some tubular mechanism in order to replace the air stored beneath their wings or in their breathing tubes. Only by such frequent restocking can they carry on their precarious submarine existence. Some of the fly young, shaped like maggots and other peculiar things, have telescoping segments at their hinder ends, which they can extend to and through the surface film for gathering air continually while the creatures burrow busily to find food in the mire. Some of the water beetle larvae not only come up to get their air but also drag living or freshly killed prey to the surface and thrust it out into the air, where it can give less resistance to being swallowed and where gravity can be of more help.

Whirligig Beetle

One of the water beetles has a greasy back which repels all moisture like the feathers of a duck. This is the whirligig beetle, which passes much of its life at the surface of ponds and streams. Actually, it is a double animal—dry above and wet below, with paddle-like feet to propel it rapidly through the water. Even its eyes are divided into an upper portion for vision into the air and a lower part with which to watch the water's depths. These beetles are very vigorous swimmers, familiar to most people as they zig and zag along the water surface, commonly in groups, leaving behind them little V's of waves like tiny speedboats.

Egg-laying

The water film forms a definite barrier for insects that must lay their eggs in the water itself, and an almost endless variety of solutions to the problem can be observed. Perhaps the simplest is that of the water lily leaf beetle, which cuts a small, circular hole in the dry top of its lily pad, pushes its abdominal tip through the hole into the water below, and while standing high and dry on a familiar surface, lays two rows of eggs on the undersurface of the lily leaf in close concentric arcs. Many dragonflies, caddis flies, May flies, and others extrude a single egg or a group of eggs from the abdominal tip while soaring over the water. They fly down close and suddenly flick the abdomen through the surface film and liberate the egg. Pulling quickly out, they zoom away to repeat the process when the next egg is ready. The insect's momentum insures it against being caught in the surface film and dragged in to drown. Much more careful are the ordinary biting mosquitoes, which literally lay a raft of eggs. The raft floats upon the water film with only its lower surface wet. The eggs hatch through their lower ends and the young wrigglers emerge into the water directly, many to be eaten at once by hungry beetle larvae and fish. The malaria mosquito, in contrast, lays her eggs singly on the surface of the water.

Another little fly, the *Dixa* midge, stands on the surface like a water strider while she deposits an extruded wet mass of eggs suspended by a strand of gelatine. As the egg mass is let down into the water, the fly adds to the supporting filament a circular, transparent disk which repels water. The disk catches on the surface film and pulls down a dimple as the strand below lengthens out and the suspended eggs sink farther into the water. The fly leaves, but the eggs with their little float drift around as the water surface is blown or as currents move the water itself. The eggs may become stuck to some vegetation or break their mooring and sink to the bottom, there to hatch.

Some other insects, when ready to lay their eggs in the water, wrap their wings around their bodies like a cloak, enclosing a bubble of air, and then crawl down stones or stems through the surface film and into the depths below. Those that succeed in laying their eggs and escaping capture in the water may later crawl back out into the air, dry off, and fly away. Male and female damsel flies co-operate in this. The male uses a pair of claspers at

the end of his long abdomen to hold the female by her slender neck. After her eggs are fertilized and seem ready for laying, the pair alight at the water's edge and the female backs into the water down some stem. The male holds on to her and remains above the surface at least as far as his wings. When the eggs have been deposited, the female starts upward and the male pulls, fluttering his wings, so that between their combined efforts, the female is brought out of the water again, to dry off and fly away.

These many special abilities and difficulties related to the water film are based on the very high surface tension which is so characteristic of this commonest liquid. Each adaptation in form or behavior is a means of using or of circumventing the strong surface forces involved. None of these methods do anything to change the surface tension itself. Yet this is possible, and is the basis of a familiar parlor trick. If a chip of gum camphor is dropped into a dish of water, the chip spins around and sails in erratic courses, propelled by a mysterious force. Actually the camphor is dissolving faster along some parts of the water line than in others, and since camphor greatly reduces the surface tension of water, the surface forces are weakest where the gum is dissolving most rapidly. The chip moves because of the inequality of surface forces pulling it from all sides. The weakest forces are behind the moving chip and show where the camphor is dissolving fastest.

One of the rove beetles makes use of this trick. Like its relatives, *Stenus* is an active little beetle, running or flying around much of its time in search of carrion or prey small enough to overcome and eat. Sometimes *Stenus* falls into a puddle or a pond. It has no waxed hair to keep its feet dry and therefore sinks well into the surface film, its legs and underparts thoroughly wetted by the water. But *Stenus* merely expels from its anal glands a substance that makes the water wetter—reducing the surface tension at its posterior end. Undiminished surface forces in front of the beetle promptly draw it forward. As long as the insect continues to emit this magic substance, it sails along with no apparent effort. Often the beetle reaches some dry object upon which it can crawl to dry off and again take to flight. This rove beetle can keep up its speedboating for many minutes, but if it is deprived of the abdominal tip with the anal glands, the insect is quite helpless in the water.

The leaves of some of our pond plants are like the whirligig beetles, with a water-shedding top and a lower surface that rests in and is wet by the water. Lily pads are of this sort, anchored to their loglike roots by long slender ropy stems. Their two surfaces support two different types of clinging life, one wet, one dry, while in between the water lily gathers up the sunshine energy to make it grow. The duckweeds too, small flakes of green, are always at the water surface. The larger kinds rest on the surface with rootlets dangling into the pond below. One of these duckweeds is our smallest flowering plant, floating freely just below the water film among the lily pads. Contrast with this the largest water leaf of the Victoria lily, whose six-foot disk with turned up rim will float a human child of medium size, all safe and dry.

When spring comes to the lake or pond surrounded by pine clad hills, the water film takes on a golden yellow cast with squandered pollen grains. The wind makes patterns of the driven dust, while the whirligigs cruise through it and raise a wake like tiny boats, rocking all the water bugs and giving rise to quiet lappings on the near-by shore. Spent and useless to the trees around, this pollen dies and sinks below. Throughout the years it may build up a layered record of the past. From just such fossil pollen we know many of the plants which lived and passed away but left no other mark. Pollen, wind, and water film combined to make a fossil trail of bygone trees.

Man and Nature

PUBLICATIONS

Science Guide No. 130

THE AMERICAN MUSEUM OF NATURAL HISTORY

Central Park West at 79th Street, New York 24, N. Y.

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FROM THE NECK UP

BY HARRY L. SHAPIRO

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Science Guide No. 131

NEW YORK

THE AMERICAN MUSEUM OF NATURAL HISTORY

1947

A WOMAN's red silk hat from Tibet, the product of a people generally regarded as backward in terms of modern civilization but possessing an elaborate religion and a rich esthetic culture

How man, primitive and civilized, exercises his fancy in decorating his body, particularly

FROM THE NECK UP

A preview of a special, temporary exhibit at the American Museum prepared by

KATHARINE BENEKER
Supervisor of Special Exhibition
Department of Education

By HARRY L. SHAPIRO
Chairman, Department of Anthropology,
American Museum of Natural History

All photographs by AMNH

THERE are living in the world today thousands of groups, tribes, populations, and nations. And among all this assemblage, it would be difficult to enumerate a dozen different groups completely content to leave their bodies as nature made them, unadorned, undecorated, and unmarked.

This passion for embellishment ignores climate, comfort, pain, or inconvenience. The dwellers in the tropics who have reduced clothing to a minimum or have discarded it altogether, scarify their flesh to produce keloid or scar tissue in patterns of bas-relief, pierce their noses to carry ornaments or other objects of virtu, elongate their necks with coils of brass, stretch their lips around huge discs, and in various other ways find means of decorating or mutilating their bodies. Inhabitants of cooler climates who find clothing a necessity also make an adornment of it, often obscuring its basic function under a mass of decorative and tortured detail.

While much of this artificial enhancement of the person is relatively of little or no inconvenience and in the case of clothing often of distinct value to the organism, men and women will endure for the sake of it incredible agony, torture, and discomfort. The comparatively mild distress of corset wearing pales before the pain of Chinese foot-binding, head deformation among the Aymara of South America, the tooth evulsion of some African tribes, and the subincisional surgery of Australian aborigines.

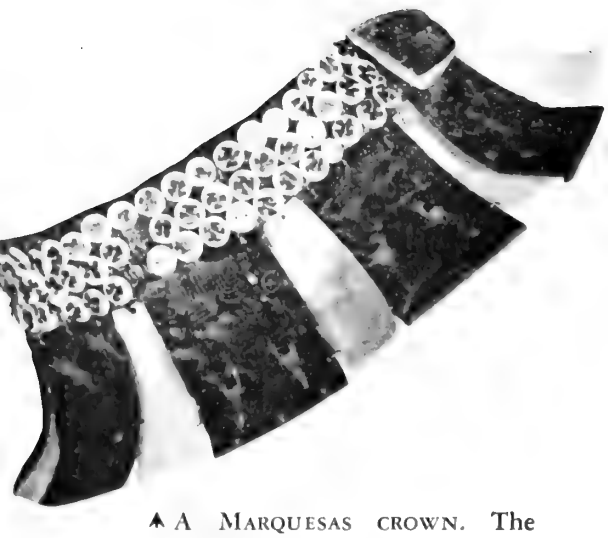
In fact, so universal is this urge to improve on nature that one is almost tempted to regard it as an instinct. Aside from such fundamental drives as those for food, love, security, and the expression of maternal solicitude, I can think of few forms of human behavior that are more common to mankind as a whole. Perhaps it is precisely because part of its motivation is involved with sexual attraction that this impulse to draw attention to the body finds an outlet among the civilized sophisticate equally with the untutored savage.

But whatever the final cause that induces mankind to adorn itself, the immediate reasons are often removed from sex and in some cases seem to have little or nothing to do with it. The caste mark on the

▲ AN EXTREME in modern American sophistication is expressed by this black felt hat with blue feathers, designed by John Frederics and set off with jewels by Cartier

▲ CONTRASTS in facial decoration. (*Top left*) A Tsimshian Indian with green face paint and copper appliqué ornaments representing the raven. (*Top right*) Charoti Indian, South America. (*Center*) Modern theatrical make-up, by Del Russo of Prince Matchabelli. (*Bottom left*) Arunta man of Australia, with face covered with feathers and blood as part of ceremonial ritual. (*Bottom right*) Mask-like effect of face paint in New Guinea employed on ceremonial occasions

▲ TYPE OF HEADDRESS worn three centuries ago by the Indians of New York State and New England: Iroquois roached headdress of dyed deer hair, with face paint, crescent earrings, and bear-claw necklace



▲ A MARQUESAS CROWN. The shell and tortoise shell are true to the aboriginal style; the commercial buttons, introduced by early voyagers and whalers, replaced native decorative elements

▲ A QUILTED RED taffeta sun hat inspired by a Tibetan woman's sunshade in the American Museum's collection. By Sally Victor

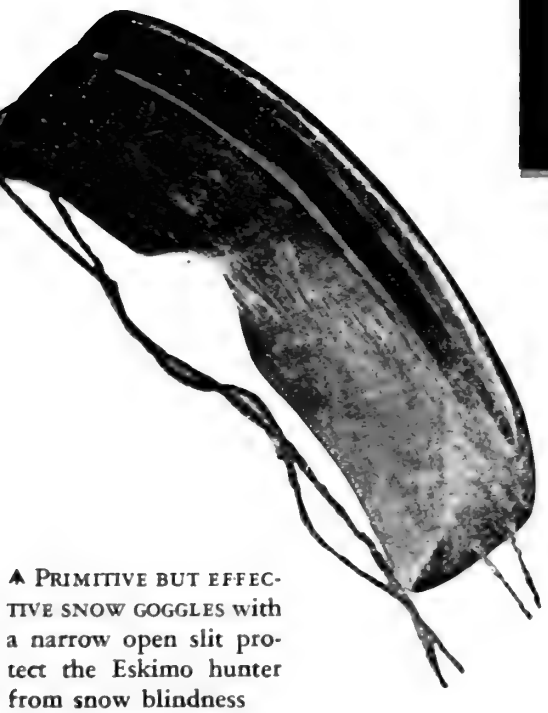
◀ A MUSICIAN'S CAP, from Tibet

Courtesy of Abercrombie and Fitch

▲ POLAROID SUNGLASSES protect the eyes of the ultra-modern vacationer

▲ A SWAN'S-DOWN HEADDRESS decorated with eagle and magpie feathers, with a mask representing an eagle, worn by the Tlingit Indian medicine man in a dance to bring good fortune

➤ FOX-SKIN CAP with eyeshade of embroidered sealskin, from the Angmagssalik Eskimos of East Greenland



▲ PRIMITIVE BUT EFFECTIVE SNOW GOGGLES with a narrow open slit protect the Eskimo hunter from snow blindness

There are two principal methods of altering the body to improve upon nature. One is permanent, the other temporary. Each has its advantages and disadvantages. In the former are included tattooing, scarification, head deformation, piercing and enlargement of lips, nose and ears, foot-binding, tooth evulsion or filing, the amputation of fingers, and various deformations and mutilations of the sex organs. Designs or modifications of this kind need no refurbishing to retain their artificial form. The elegant designs that covered the Marquesans from head to foot in highly complex and delicate patterns and entranced the early voyagers would have been too laborious to apply for anything but rare and special occasions if they were impermanent. By tattooing them, however, a lengthy and painful series of operations furnished an individual with a superb and ineradicable decoration requiring no further attention but also admitting no

change. The flattened head of a Northwest Coast Indian might delight him as a mark of prestige, but it would permit no afterthought.

The temporary forms of bodily decoration embrace an enormous range and have the advantage of allowing for change. Body and face painting, ornaments, headdress, the vast array of jewelry, flowers, hats, clothing, and shoes can be put on or taken off according to the desire of their possessors. They require attention, and if valuable they represent wealth liable to loss or theft. They entail, as in the coiffure of Japanese or in the make-up of European and American women, tedious hours of grooming, but they allow for change and variety.

▲ INTRICATE DECORATIVE ELEMENTS fashioned of metal and kingfisher feathers adorn this bride's hat from China

▲ DOUBLE SPIRAL HAIRDRESS of a Bangba man on the Aruwimi River, in the Belgian Congo

▲ MANY of the fanciest decorative effects in primitive groups are evolved by the men. An unusual beard esteemed by a tribe in the Congo

▲ HAIR-DO EXTROADINAIRE: an Abarambo woman of Mangalu Poko, in the Congo

▲ HAIRDRESS worn by the unmarried girls among the Hopi Indians of Arizona

▲ A HEADBAND that on first glance might be either primitive or civilized. By John Frederics

▲ INSPIRED by a South American Indian feather headband in the American Museum's collections: a modern red felt skull cap with a brim of brown and white feathers. By Sally Victor

▲ MODERN VERSION of the Plains Indian war bonnet. Originally worn only by warriors who had achieved distinction in battle, it has now been adopted by many tribes beyond the plains

To list the materials and objects that men and women have found decorative or useful in creating personal adornments would require a great deal of space. They include such classifications as stones, bones, ivory, teeth, feathers, furs, hair, grasses, flowers, plants, fibers, insects, animals, birds, fishes, metals, plastics, ceramics, wood, beans, seeds, and shells. And they range from simple objects used as they are to the results of the most complicated technologies. They represent the crudest forms of adaptation as well as the most elaborate esthetic developments, in some instances approaching the status of fine art.

All these adjuncts to and modifications of the human body are not necessarily meant to be esthetic, Many are, as I have already mentioned, either utilitarian or symbolic and ritualistic. But the creative spirit of man tends to endow even these with some aspect of decoration, or by their very nature they take on a decorative quality. This brings me to the necessity of stressing that the standards of what is beautiful are shifting and ephemeral. Those of us who find the adornments of uncivilized men barbaric, bizarre, or unlovely should remember that nothing appears more ludicrous, exaggerated, or exotic than our own styles of "only yesterday," when time has not yet rescued them from abandonment and refurbished them in the cycle of taste and fashion.

The photographs shown on these pages are drawn from a temporary exhibit in the American Museum, designed to illustrate the human fancy expressing itself on a part of the body—from the neck up. Even within this limited region the variety and ingenuity displayed is astonishing, but it represents only a fraction of the ways with which man has dealt with his body for purposes of adornment, symbol, distinction, prestige, utility, and sex. Apparently all men are brothers on the skin.

◂ A BLUE TURBAN with red tapestry trim, inspired by a Chinese turban from northern Yunnan. By Sally Victor

▾ HEADGEAR WORN by the principal wife of a Mayogo chief, in the northern Ituri District in equatorial Africa: a bristling circlet of dog's teeth, surmounted by a basketry cap adorned with feathers and bone hairpins

▲ BASKETRY HAT decorated with boar's tusks, worn by the Bontok Igorot warrior, Northern Luzon, Philippine Islands

▲ HEADGEAR worn by the Azandi, Niangara, Congo, Africa. Basketry base decorated with feathers

◀ FUR AND SILK HAT from Mongolia

▶ RATTAN HAT from the Ilokano tribe, Northern Luzon, Philippine Islands

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The Life History of the Monarch Butterfly

By LUCY W. CLAUSEN

THE LIFE HISTORY

OF THE

MONARCH BUTTERFLY

by Lucy W. Clausen

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THE AMERICAN MUSEUM OF NATURAL HISTORY
1948

Monarch butterflies in their natural habitat, showing all stages in the life history. Photographed from a group in the American Museum of Natural History.

AMNH photo

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The Life History of the Monarch Butterfly

By LUCY W. CLAUSEN

Introduction

Since all insects are not alike in their looks or in their habits, scientists have divided them into groups known as orders. Each group consists of insects with similar characteristics. Some orders include insects which are quite primitive. Other orders include insects which are highly complex and specialized. Within the twenty-seven commonly recognized orders of insects, the hundreds of thousands of species known today have been classified. Estimates of the total number vary from 500,000 to 750,000. Whatever the actual number, it is still true that there are more species of insects — many hundreds of times more — than all other species of animals put together. Nor is the end yet in sight. More than 10,000 new species are described every year.

One way the scientist is able to classify a new species of insect is by the kind of life history it goes through from egg to adult. Certain species show a primitive change in body form, or metamorphosis, in which the egg hatches into a nymph which closely resembles the adult. The higher orders have a complex metamorphosis in which the egg hatches into a larva; the larva feeds and grows and then goes into a pupal stage; from the pupa, the adult emerges as a free agent, capable of reproducing its kind.

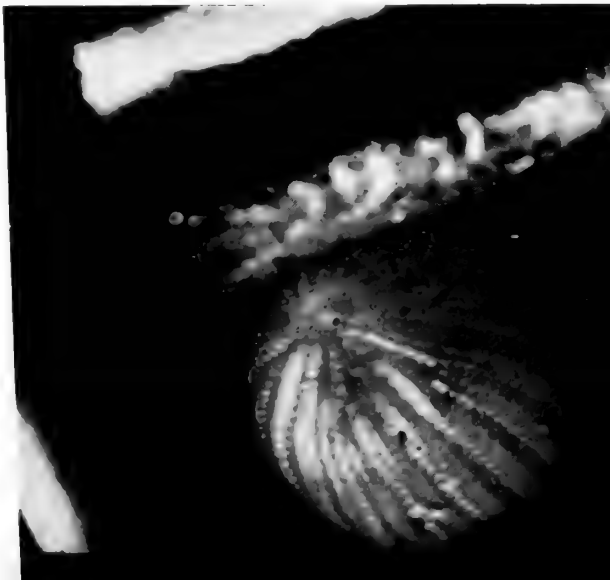
The complex life history of the higher insects is as unique as it is intriguing, and its study is a constant source of interest and amazement to the uninitiated. The monarch butterfly affords an excellent example of this complex metamorphosis and as a familiar sight in city parks and in the open country, it is well enough known to most people to be of popular interest.

Stages in the Life History

Egg. The monarch butterfly (*Danaus plexippus*) starts life in a pale, greenish-amber egg. The female lays her eggs singly on the underside of milkweed leaves, and the eggs cling there like tiny droplets of moisture. Protected on the under surface of the leaf from the drying rays of the sun, yet warmed by them, the eggs develop and hatch into caterpillars in about a week.

Larva. The larva finds a ready source of food upon hatching. This is fortunate for the caterpillar because it has an enormous appetite and consumes great quantities of milkweed leaves. It spends most of its time eating, with the result that it grows and at the same time stores enough food to meet the rigid requirements of the non-eating pupal stage.

The caterpillar is brightly colored with alternate bands of white, black, and yellow the length of its smooth body. At each end, it has a pair of thread-like "horns" which serve as feeling organs as it moves about in search of food. The fact that it feeds almost entirely on milkweed leaves has earned it the common name of milkweed caterpillar.

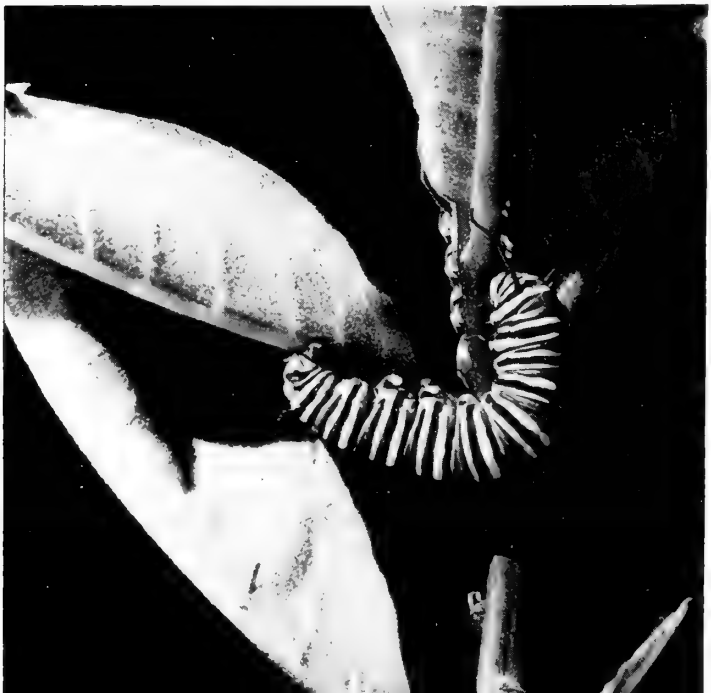


Egg of the monarch butterfly on a leaf of the milkweed plant. Enlarged.
Photo by C. M. Grafton

The larval stage lasts one or two weeks. During that time, it grows too big for its skin and splits out of the old one and grows a new one. This molting occurs several times until the caterpillar attains a length of about two inches. Then it is ready for the chrysalis or pupal stage.

Chrysalis. Once it starts, the change from caterpillar or larva to chrysalis or pupa is completed in about a half hour. The larva shortens and thickens and soon becomes completely encased in a translucent green capsule with shining flecks of gold across its surface. Hence its poetic description as "the green house with the golden nails". This pupal case is formed inside of the last larval skin which then splits and slides back to reveal the new pupa.

Milkweed caterpillar feeding. *AMNH photo*



Milkweed caterpillar attached to a twig by the tail showing the beginning of the pupal case in the region of the head.

AMNH photos

The body of the caterpillar completely encased with the shed larval skin crumpled at the point of attachment.

Chrysalis nearly complete with segments visible through the translucent case.

The larva seeks the underside of a strong midrib of a leaf for this change. There it spins a silk thread from its mouth and by means of this thread, attaches its tail firmly to the leaf. The larva hangs downward and curves the head back slightly on the rest of its body so that it looks roughly like the letter "J".

Shortening and thickening begin in the head region and progress backwards towards the tail. They are accompanied by a rapid growth of the pupal case and a gradual disappearance of the bands of color. The insect is known at this stage as the prepupa since the loosened larval covering is being replaced by the pupa case.

The body of the larva is divided into fairly regular segments from head to tail similar to the body of an earthworm. During the change from larva to pupa, some of these segments fuse. Those which remain can be plainly seen through the pupal case, and a close scrutiny also reveals the breathing pores or spiracles. When the pupal covering is completed, the discarded skin remains crumpled near the point of attachment.

After it is completed, the pupal case, dangling by its black silken thread, gradually turns darker. To an observer, the pupa seems to be resting, but actually there is an amazing amount of activity going on inside. The insect is being completely remade. An immature feeding machine is being transformed into a free-ranging adult.

This regenerative process is poorly understood at present. No one seems to know the exact details of what happens in the chrysalis stage. However, when the process is completed, the new adult lies dormant and closely packed in the pupal case for a while, ready to respond at the proper time to unknown stimuli which cause it to break out, fully developed.

Adult. At the time the adult emerges, red and black markings of the wings can be seen through the pupal skin. This skin breaks open, and the butterfly laboriously draws itself out of its confined quarters and expands. The wings unfold rapidly. At first, they look like a crumpled paper bag, but in a short time they straighten out and attain their full size and form. Exposure to the sun and air cause them to harden and dry, and the butterfly is ready for its first flight.

Metamorphosis is complete. From a crawling caterpillar with short legs, chewing mouthparts, simple eyes, and practically no feelers or antennae, the insect has changed into an adult with long legs, sucking mouthparts, compound eyes, long sensitive antennae, and beautifully colored wings. It will grow no more.

The color of the monarch's wings serve as one quick means of identification. This is true of many butterflies and is possible because the wing surface is large in proportion to the rest of the body and because the wings are permanently fixed in a non-

Chrysalis just prior to splitting open, with wing clearly visible under the case.
AMNH photo

Chrysalis case split up the side and adult just beginning to emerge.
AMNH photo

Left — Emergence of the adult. Monarch struggling free of the split pupal case.
Below — Adult butterfly on a clover blossom after the wings have dried and hardened.
AMNH photos

folding form, in contrast for example, to the wings of a grasshopper which are folded when not in use. The general color of the milkweed or monarch butterfly's wings is a tawny red. The outer edges are black with white spots, and the veins are outlined in black. This coloration is due to tens of thousands of tiny colored scales which come off the wings in the form of a fine powder when rubbed. If the wings are denuded of their scales, a butterfly is hampered in flying. Because all butterflies

and moths possess scaly wings, they have been placed in the order Lepidoptera, from the Greek *lepido,* scale, and *pteron,* wing.

The first three or four days of the insect's adult life are spent feeding on the nectar of red clover, milkweed, butterfly weed, goldenrod, aster, thistle, and other favored plants in the vicinity. It is admirably equipped for securing the sweet fluid from these flowers. The butterfly has a tube or proboscis extending from its head when feeding. This tube can penetrate to the interior of a flower and suck up the nectar. When not in use, this proboscis lies coiled up like a watchspring under the head.

Flight

The monarch's vivid coloring makes it conspicuous in its natural surroundings, and yet it sails along in easy flight without any attempt to seek the safety afforded by the foliage of shrubs and trees. It is safe from one of the enemies of most other insects, the birds; they will not molest this butterfly because they find it disagreeable and distasteful as a source of food. The milkweed caterpillar is relatively safe for the same reason.

Normally, the monarch flies along at a speed of six or seven miles per hour anywhere from six to twelve inches above the flowers among which it seeks its food. When it is over barren ground, however, it increases its altitude to three or four feet

Drawing of the mouthparts of an adult butterfly in the resting or coiled position, with the large compound eyes showing above the coiled proboscis. *Photo by A. Howard, from a drawing by Alice Gray.*

and its speed to about fifteen miles per hour. If it is frightened, it will rise as high as two hundred feet in a great rush of wing action.

Long glides are frequent. The insect does not stay on an even keel when it glides but seesaws from side to side, putting first the left wings low, then the right wings. This results in a teetering forward movement and a general direction similar to the tacking of a sail boat. It is by means of the seesaw movement that the butterfly steers itself when it glides.

The monarch's flight is not confined to land areas alone. It also flies over water but at such a height that it is barely visible to the naked eye. Its speed over water has been estimated to be as high as twenty-five miles per hour. As soon as it gets over land again, it quickly descends and flies at its normal height and speed.

Most collectors are aware of the monarch's habit of playing "possum". When it is caught, it falls on its side and lies motionless as if dead. If uninjured and left unmolested for a short time, it rights itself and flies away quickly.

Mimicry

The monarch's distastefulness to birds has already been mentioned. This is its chief means of protection. The viceroy butterfly, *Basilarchia archippus,* on the other hand, makes a tasty morsel for birds, but because it closely resembles the monarch in appearance it is believed that birds do not distinguish between the two and hence do not eat either of them. The viceroy's imitation of the monarch's appearance is known as passive mimicry because the monarch does not actively cooperate in protecting the viceroy.

The viceroy can be distinguished from the monarch by the presence of a narrow black band across the hind wings and by its somewhat smaller size. In flight, the monarch makes slow deliberate flaps with its wings and glides with the wings held

at an angle. The viceroy makes quick flying strokes and holds its wings straight out from the body when it glides.

Migration

Many butterflies, including the monarch, are extensive travellers. The monarch, so common in the northern latitudes, flies south thousands of miles for the winter.

In the fall of the year, monarchs assemble in countless numbers along the northwestern coast of the United States. They cling to the leaves and branches of trees, and it is not uncommon to see bushes and branches actually bent with the weight of

The viceroy butterfly, right, compared with the monarch, left, indicating the viceroy's mimicry of the monarch's coloration.
Photo by A. Howard

hundreds of thickly massed butterflies at rest. As if by some pre-arranged signal, these clustered insects arise in a great cloud and disappear southward to spend the winter months in the Gulf States.

How they keep their direction over land and water, even in the face of strong winds and storms, is still a mystery. How they find their way over rivers, forests, swamps and cities, when none of the individuals in the swarm have ever made the flight

before; what their destination is once they leave the north; whether the same butterflies return north the following spring, or whether they are a new generation born during the winter; these are some of the questions about the monarch's migratory habits which science cannot answer at present.

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Adult monarchs clustered just before migration. Photographed from an American Museum of Natural History habitat group.
AMNH photo

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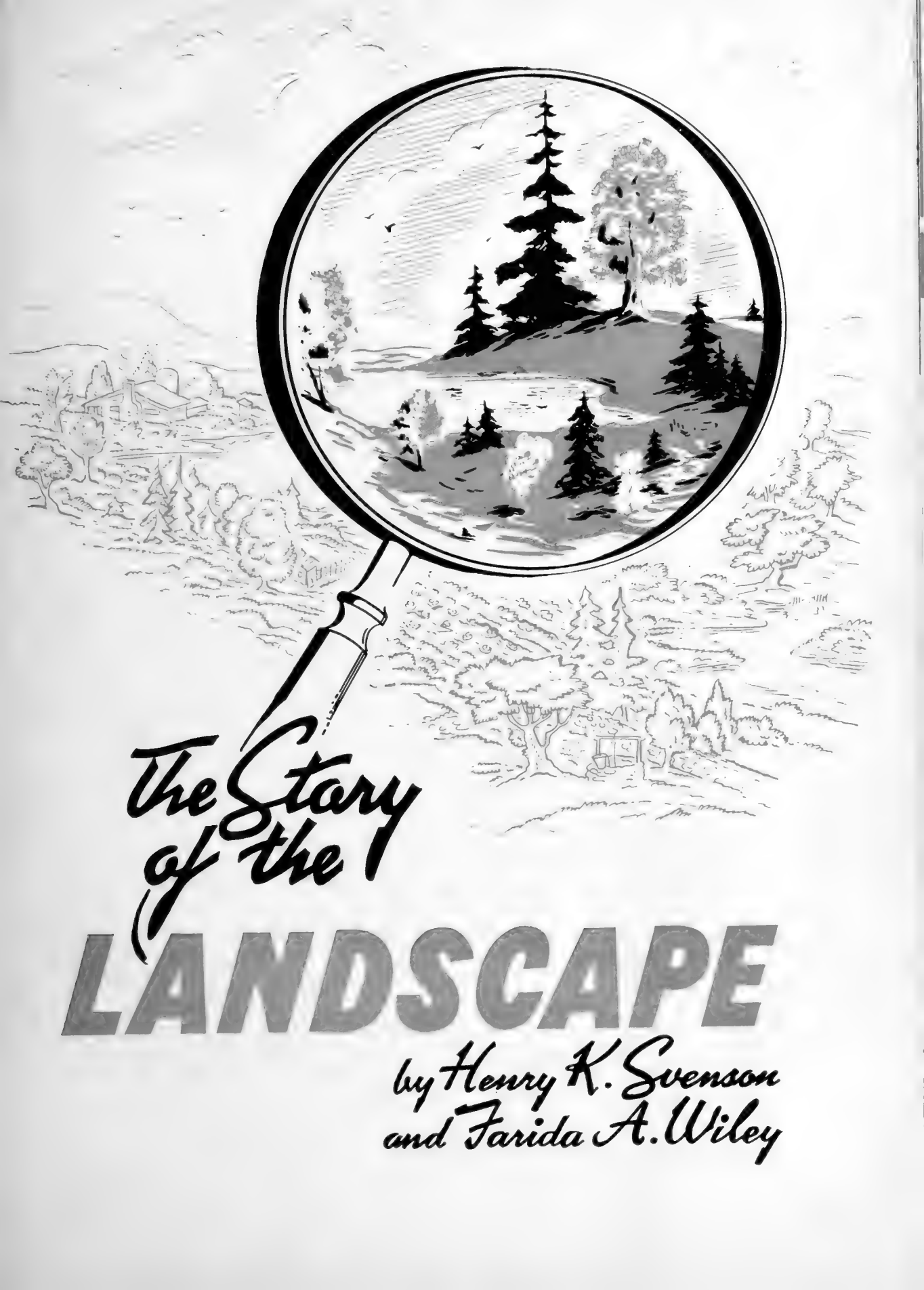

The Story of the LANDSCAPE

by Henry K. Svenson
and Farida A. Wiley

The Story of the LANDSCAPE

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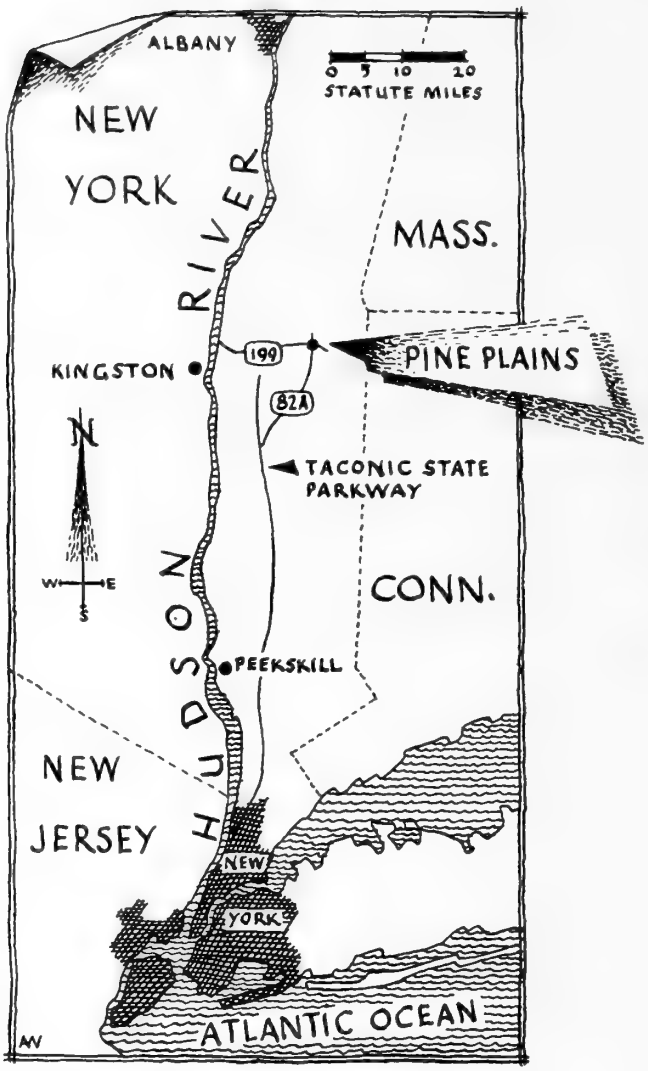
Science Guide No. 133
A guide to the Felix M. Warburg Memorial Hall

Man and Nature Publications
The American Museum of Natural History
New York City
1952



In Dutchess County, ninety miles north of New York City, lies Stissing Mountain and the village of Pine Plains. Here, as in other parts of the world, each individual feature of the landscape is the home of definite plants and animals whose lives depend upon their environment and upon one another.

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An October afternoon near Stissing Mountain.

Introduction

A steady procession of automobiles goes out from New York City every weekend. At intervals along the parkways there are lookout areas thronged with sightseers who stop to enjoy the landscape, with its views of mountains, lakes, farmlands and woodlands. The landscape varies during the season and, for many people, has its greatest attraction when the leaves are unfolding in the Spring and again when they have achieved the brilliant autumnal colors in the Fall. At all times of the year, however, the countryside is a constantly changing scene of interest.

Although the city dweller usually looks upon the landscape from quite a different point of view than the farmer, each needs to have a real understanding of its interrelationships. By taking a definite region as the basis for detailed explanation, the complexities of the landscape can be better understood by both the city dweller and the man of rural areas. This is what the Warburg Memorial Hall attempts to do in its analysis of a small area near the village of Pine Plains, which is located on the east side of the Hudson River, 90 miles north of New York City.

This landscape is variable in contour and presents many types of natural and cultivated lands. Differences in the contours of the landscape are due mostly to the varying hardnesses of rocks which have been eroded by rain, frost, and running water. Also the deposits of sand and clay left by the ice sheet of the last glacial period have in the course of time tended to become worn down and less prominent. Such a landscape confronts the visitor who enters the Warburg Memorial Hall from the 77th Street entrance of The American Museum of Natural History, as he views the large habitat group of Stissing Mountain located at Pine Plains, New York. The scene depicts the brilliant autumn coloring typical of this region. The islands in the lake are bathed in an intense yellow glow from the rays of a late afternoon sun which break through a cleft in the mountains. The rest of the panorama, lying in the shadow of subdued light, extends from the mountain slopes southward to the rich farmlands beyond the lake. Sumac, birch, cherry, poplar and oak are among the more prominent plants while the red fox, blue jay, red-tailed hawk, black duck, monarch butterfly, praying-mantis, and a large ant hill are incorporated in this group as typical of such a locality.

The area depicted in this habitat group furnishes a backdrop for the ecological ideas presented in the hall. These ideas illustrate what happens in water, soil, and man-controlled areas.

Topography

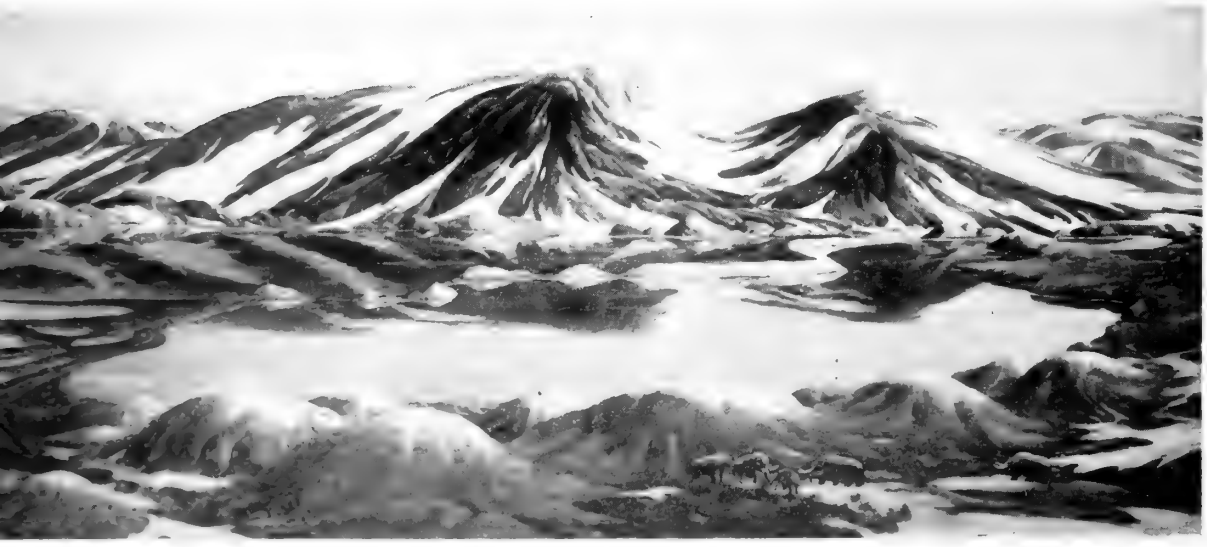
The long ridge of Stissing Mountain stands out as the most prominent part of the landscape, dominating the farmlands, woodlands, houses and roads in an area eight miles long and five miles wide. The granitic rocks of this mountain have weathered more slowly than the limestones, and therefore form the rugged contours. Limestones disintegrate into soil to make good farmland, having had locked up in them the fertilizing elements, such as phosphates of the ancient sea which once occupied this area.

Geological History

Millions of years ago the mass of Stissing Mountain rose gradually out of the sea, and has since undergone geological folding and the weathering processes of rainfall, frost, ice, and running water, which we call erosion. This mountain, a part of the ancient New England upland, lies halfway between the Hudson River and the western boundary of Connecticut. Its geological history differs from that of the non-folded Catskill Mountains which lie to the west of the Hudson River and which are so prominently seen from the uplands near Pine Plains village.

Layers of sand and mud were deposited in the ancient seas on the primeval granites, and these deposits gradually hardened into sandstone and shale rocks which were later raised above the water. The granites resisted erosion and became the core of the mountain. In the limestones, deposited as organic material in the ancient sea, one may find various kinds of fossils representing animals long extinct. These fossils often have curious and artistic shapes. Probably red Triassic sandstones, such as are found in New Jersey, once covered this area. Eastward in the Connecticut Valley such sandstones contain footprints and even occasional skeletons of dinosaurs. At the close of the recent ice age, mastodons and woolly mammonths roamed at the fringes of the disappearing ice; their gigantic teeth are occasionally found in the sand and clays of Dutchess County. As has been mentioned, the limestones underlie the best farmlands. Shales underlie the less fertile uplands, which were to a large extent abandoned by farmers in the last century, and are now growing back into forest.

Retreating ice during the close of the recent ice age.



The water table is determined by the amount of rainfall plus the structure of the underlying materials.

Water Cycle

Rain water percolates into the ground until it reaches a level where clay or rock stops penetration. The upper levels of this saturation zone is called the water table.

Springs, lakes, ponds and marshes often occur where it comes to the surface. Water evaporates from the surface of these bodies of water, leaves of plants and from the ground to form clouds. Upon contact with colder air these vaporous clouds further condense and are returned to the earth in the form of rain, sleet or snow. Thus there is a cycle of water from the land and ocean to the air and back again.

The intelligent farmer takes care of his supply of water. He plows fields on the contour and not up and down the slope. In this way he prevents the creation of little vertical gullies, which if unattended, would eventually carry away great sections of hillside farmland. The continuous action of running water wears down the surface of the land. Where lands are unprotected by plants the run-off of water carries with it particles of earth, and the result is disastrous erosion. To prevent erosion, grasses and legumes are planted on sloping farmlands, and the farmer leaves a protecting forest on the uplands.

Microscopic animals

Glaciation

During and after a heavy rain, soil erosion and cutting of stream banks can readily be seen. A much greater erosion resulted from the moving and melting ice of the glacial period. The moving ice gouged out valleys, scraped and polished the rocks, and removed the original soil. In many places sand and rocks were strewn about the land. Such glacial features are prominent in the Pine Plains landscape. They appear as glacial hills (or kames), as circular ice-block depressions, and as transported boulders scattered here and there. Actual scratches made by rock fragments carried in the ice can often be seen where rocks are exposed. Glaciation had a profound effect upon the agricultural land of New York and New England. The comparatively thin layer of stony soil in this area which has been constantly abused by man, could not compete with the deep, fertile unglaciated lands of the Mid-west, when these lands were opened for settlement.

Soils and Soil Conservation

From this discussion of geology it will seem that the soils of the Pine Plains region are complex in origin. As each kind of rock breaks up, it tends to produce a different soil, for rocks are made up of various minerals. These minerals can be seen in the sands along the stream beds — glassy particles from the quartz, dull gray fragments of feldspar, black specks of hornblende, and the gleaming particles of mica. Feldspar finally breaks down into microscopic clay particles. Soils are classified according to the amount of sand, clay and silt which they contain. The ordinary garden or top soils, characteristic of our region, are known as loams. Their fertility generally depends upon the amount of humus, remains of plants and animals, which they contain.

Layers of topsoil vary greatly in thickness. Soil is produced slowly at the surface of the earth from the action of air and water upon minerals, and by decay and the action of a vast number of microscopic animals and plants working both above and below the surface. In the Pine Plains area the greatest depth of top-soil accumulates along the flood plain of stream banks, much as it does along the fertile banks of the Nile.

Soils should be carefully ploughed on the contour or strip-planted to prevent erosion. Top-soil is the country's greatest asset, and if it is destroyed by erosion or burning of the forest, centuries may be required to bring it back.

Stratified Sands and Clays *Glacial Till* *Alluvial Soils*

Stratified sands and clays were laid down by glacial water from the melting Ice Sheet. In unglaciated regions, bedrock decomposes gradually upward into soil.

Glacial till is unstratified material left by the Ice Sheet. The poor soil which it forms induced the settlers to move west to the better prairie soils.

Alluvial soils are formed by the overflow of streams. In this section fertile top soil rests on a clay subsoil.

Relation of Plants to Geology and Soils

The adaptability of some plants makes it possible for them to grow in several kinds of soil, while others are restricted to a definite type. The large yellow lady's slipper usually occurs on shaded slopes of limestone hills, where plant remains form a rich moisture-holding litter. The pink lady's slipper grows in sterile sandy soils, or sometimes in acid bogs. The showy lady's slipper is characteristic of cool cedar or larch swamps which lie above limestone.

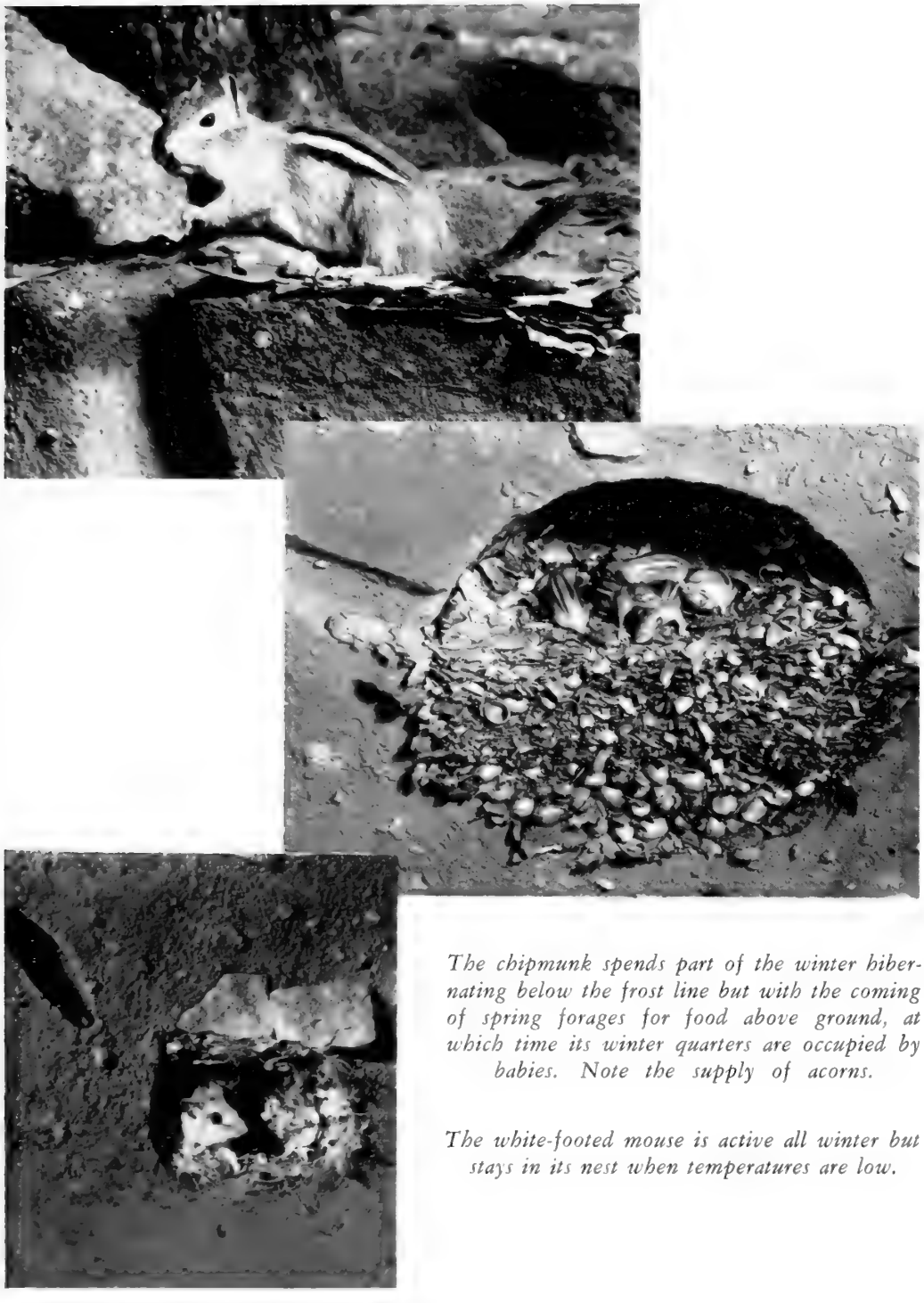
At Pine Plains Halcyon Lake has a conspicuous white border or marl, composed of shells and of the deposits which adhere to aquatic plants in limy waters. Marl was once used by early settlers as a fertilizer in place of lime. Such marl deposits are unusual in New York State, the best known being the famous Bergen Swamp in Genessee County, which has a wealth of unusual flowering plants.

Life in the Soil

Many plants and animals live beneath the surface of the earth and if a section could be exposed, as shown here, one would be astounded at the wealth of interesting living things existing below ground. Animals increase soil fertility by digging holes thus mixing and ventilating the soil allowing air and water to penetrate to the plant roots. Air is just as necessary for the growth of plants as it is for animals.

The little striped squirrel or chipmunk of the Eastern States digs tunnels and stores a plentiful supply of acorns for the winter. It also constructs a nest below the forest line, where the young are born in early spring. Moles, earthworms and many insects go down into the subsurface. For living quarters, yellow jackets often use nests which have been abandoned by mice. Many kinds of ants tunnel far below the surface of the ground and bring up particles of sand, which may grow into large mounds.

Winter is an inactive season for many forms of life. The toad often spends the summer catching insects among the farmer's plants and then may seek refuge from the winter's cold in an abandoned corner of the mole's tunnel. In their search for insects moles burrow under the ground. Pine mice may also use an abandoned mole's tunnel to reach and feed upon the farmer's bulbs. Larvae of the Japanese beetle make yellow patches in the farmer's lawn by eating the grass roots during the summer. They move farther down into the ground to escape the cold of winter. Moles and earthworms do likewise. The moderate temperature existing about 18 inches below the surface furnishes a safe retreat for many forms of life.



The chipmunk spends part of the winter hibernating below the frost line but with the coming of spring forages for food above ground, at which time its winter quarters are occupied by babies. Note the supply of acorns.

The white-footed mouse is active all winter but stays in its nest when temperatures are low.

Destructive action of pelting raindrops falling on unprotected soil.

Roots in the Soil

Below the surface, plant roots take up the nourishing mineral substances dissolved in soil water. In addition to rock particles and the organic substances in humus a definite amount of water and air is necessary in the soil for plant growth. These minerals and organic materials are absorbed in water through microscopic projections known as root hairs, which occur only on the smallest root-branches. When plants are moved, root hairs easily break off or dry out. Even when great care is taken, transplanting is not always successful. Underground parts of plants are not necessarily roots; for example, carrots and turnips are true roots, but tulips and onions are bulbs in which underground leaves are enlarged for food storage. Underground stems may be enlarged to form tubers, as in the white potato.

Seasons of the Farm; Rotation of Crops

On the farms as well as in the woodlands, plants have different soil requirements. Alfalfa grows best in deep fertile soil. Wheat grows best in soil containing some clay, while tomatoes thrive in light sandy soil. Various crops are planted to succeed one another during the season. Winter wheat, rye, barley and various cover crops are planted in the fall. They sprout quickly, grow several inches by winter time, and serve to hold soil in place by protecting it against the destructive erosion caused by pelting rain drops, and the run-off from rain and melting snow. Oats are sown early in the spring and harvested by mid-summer. Corn is planted in late May and harvested in the fall. Generally the fields are kept in timothy and alfalfa for about five years before the ground is broken up for corn planting. Corn rapidly exhausts the soil of nutriment and for that reason is grown one or two years in succession, and then followed by a year's wheat or rye, and by several years of clover, alfalfa, or clover mixed with timothy. This procedure is known as rotation of crops. By plowing these leguminous plants into the soil, the nutritious character of the soil can be restored as will be explained under the subject of fertilizers.

Seeds of corn and beans behave differently in the way the sprouts come to the surface. The corn leaf forms a spear which emerges from the ground, leaving the kernel with its food reserve behind. The bean sends up two seed leaves (cotyledons) and these leaves not only function as food reservoirs, but also serve in food manufacture (photosynthesis).

Hind leg of bee showing pollen basket.

Apple Orchard

The apple orchard passes through a series of stages during the seasons. At flowering time bee hives are placed in the orchard, and the honey bee here acts as a substitute for insects that are killed by spraying. Together with wild bees, these friends of the orchard collect pollen as food for young bees in a structure known as the *pollen basket*. During the collecting, some of the pollen is transferred from flower to flower, and so insures fertilization which results in the growth of the fruit. The orchard has numerous enemies. The codling moth lays an egg in the flower just after the petals have fallen and the larva eats its way into the apple, becoming the well-known "worm". Two broods of codling moths hatch during the year. It is necessary to spray the trees at least two or three times to kill the moths as well as other injurious insects. Some farmers spray as much as fifteen or twenty times a year, all of which helps to increase the cost of apples. Many insect pests are brought in from other countries — for example, codling moths came from Europe, where they are usually held in check by the natural enemies of their native land.

Apples are picked during the summer and fall. McIntosh is the most popular in New York State; but King, Russet, Rome Beauty and a few others survive from the many kinds formerly grown. During the picking season, yellow jackets are commonly found buzzing around apples to get at the sweet sap. In the spring they are important in carrying pollen from one flower to another.

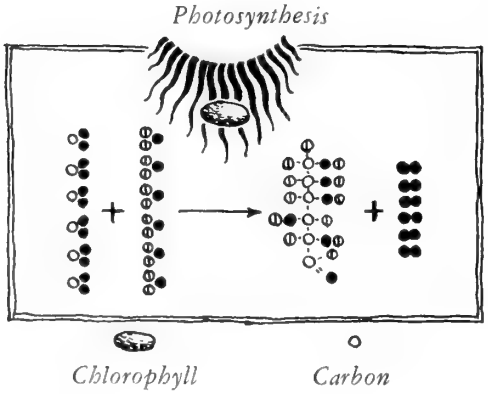
"Worm" (larva) of codling moth.

Fertilizers

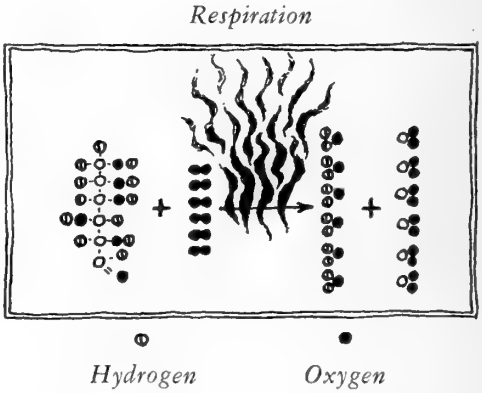
In discussing rotation of crops, it was noted that plants take nutriments from the soil. To balance this loss the farmer has to add fertilizers, which may be lime, nitrates or phosphates. These come from a variety of sources. Wood ashes, fish and guano were extensively used in the early days. A common method is to plant legumes such as red clover, soy beans or alfalfa, for these green fertilizers have nitrogen-fixing bacteria in nodules on the roots. These nodules store nitrogen that the bacteria have derived from the air in the form of compounds which are converted into usable plant foods. Thus, foods become available when the plants die or when they are turned back into the soil by the farmer. Red clover is perhaps the most important agricultural plant of Europe. For centuries it has been used for building up the nitrogen content of farmlands. It is commonly used in this country for the same purpose.

Cycle of Nutrition and Decay

The sun is the source of energy for all green plants, and is therefore indirectly the source of the energy of all animals; for an animal that eats other animals must depend, eventually, on one that eats grass or other green plants. The sun's energy is trapped by a green substance, chlorophyll, found in all green plants, and in which the process of photosynthesis takes place. The greatest possible area of chlorophyll is exposed to the sunlight as is seen in the struggle of leaves for a place in the sun. Details of the process of photosynthesis are not well known, but water taken up by the roots, and carbon dioxide from the air are combined by chlorophyll (in the presence of sunlight) to form sugar. Energy is stored in



Sunlight shining on chlorophyll allows carbon dioxide and water to combine to form a molecule of sugar in which energy is stored. This process is known as photosynthesis and occurs only in green plants.



In the reverse process of respiration the sugar is burned, giving off energy and leaving the inert substances—carbon dioxide and water—with which the process started. Respiration occurs in all plants and animals.

the sugar and oxygen is a by-product. The energy of such additional foods as fats and proteins is ultimately derived from sugars. In the reverse process (respiration) oxygen is added. There is a slow burning, during which energy is released, and carbon dioxide and water appear as the end products of the combustion of sugar. Photosynthesis takes place only in green plants; respiration occurs in all plants and animals. In the final breakdown of all plant and animal bodies, much of the substance is returned to the earth. There are many organisms that aid in the process of decay, among them being scavenger beetles, flies and other insects, and fungi (including molds and mushrooms), but of the greatest importance are various bacteria. Numerous soil bacteria work on products of decay and transform them into chemical compounds suitable for plant food. Thus a whole chain of organisms is responsible for the breaking down of plant and animal tissues into elements that can again be used by plants.

To illustrate this cycle, let us consider an event common to most rural areas. Carrots and cornstalks derive sustenance from the soil, and in turn they are eaten by rabbits, or are thrown on the refuse heap. All products of decay undergo transformation during the cycle, part of which takes place above ground and part below ground (chiefly the work of soil bacteria). This completes the cycle of nutrition and decay. As an additional source of plant food, the previously mentioned nitrogen-fixing bacteria on roots of legumes play an important part.

So far we have dealt with the mountain and its formation, the effect of water on the soil, the habitat of plants and animals in relation to the soil, the farmer's use of soil and its replenishment, and the production of all food by plants. We now come to the interaction of plants and animals in various habitats of the landscape.

From Fields to Lake

This exhibit depicts a day in early June, along the lake below Stissing Mountain. It contrasts with the autumn scene of the same region at the entrance to the hall, and tries to convey the idea that in each of the varied situations a definite group of plants and animals lives together, and that each one is highly modified to survive in its own particular habitat.

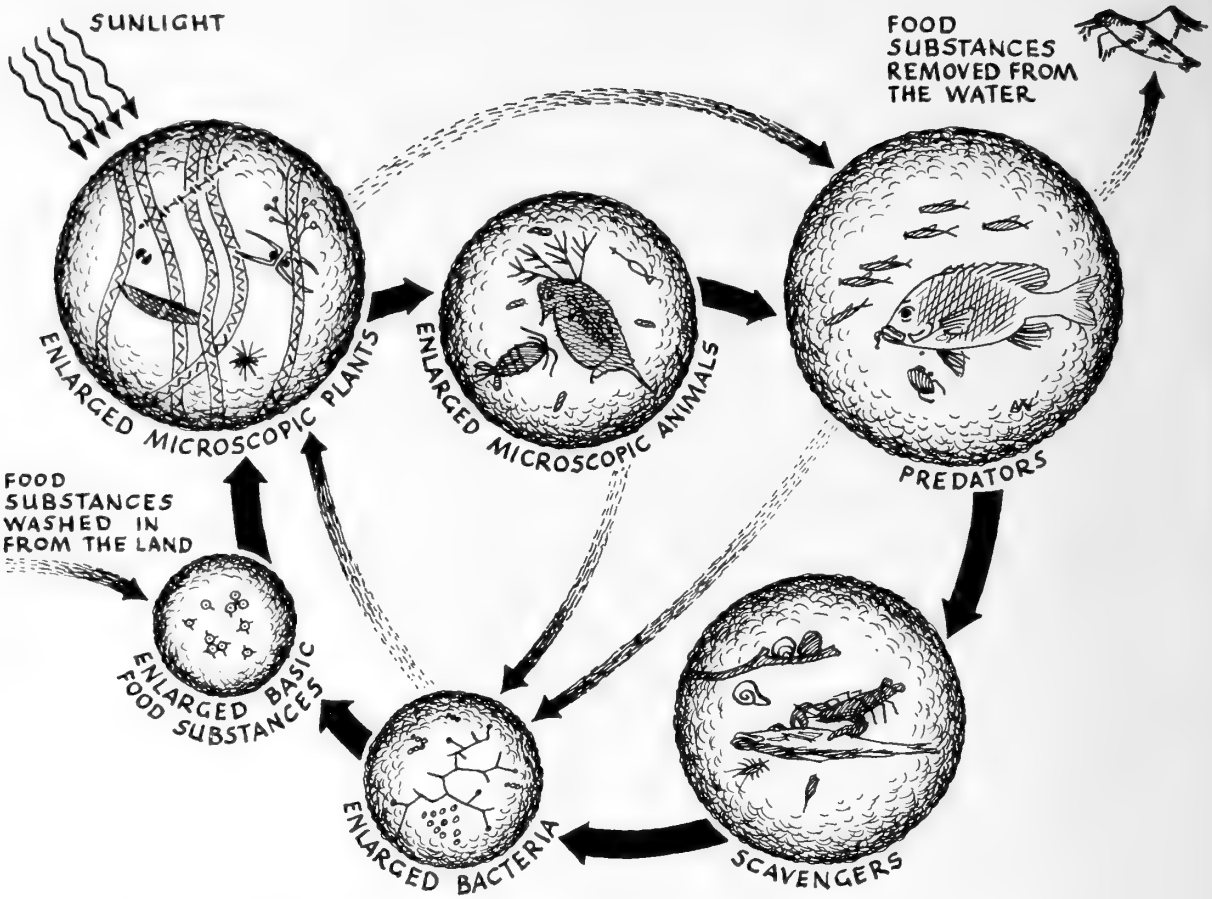
This panoramic view shows a cornfield, a meadow, a brook, a forest, and a cattail swamp, as well as many of the plants and animals that find here the food and protection necessary for their survival.

Within these areas are predators (feeding on other animals), herbivores (feeding on

plants), and scavengers (feeding on dead material). All are dependent directly or indirectly upon the actions of living organisms and the presence of certain non-living elements.

To raise corn the soil is plowed about a foot deep, then harrowed, and the corn planted in late May. Now in early June it is a few inches high. In the distance is a flock of crows. At nesting time, it is true that crows pull up the soft corn grains to feed their young, but on the other hand, they do some good by devouring beetle grubs that eat corn roots. A pathway made by fishermen follows the brook, now filled by spring freshets as it winds through meadows colorful with iris and buttercups. Large willows which thrive best with their roots in wet soil are seen in the background. On the drier banks are flowers of wild strawberry and blackberry, and in the running well-aerated water is a speckled brook trout. Red maples are characteristic of the New York swamp areas, which at this season are filled with the luxuriant green leaves of skunk cabbage. The flowers of skunk cabbage appeared earlier in the spring. Shaded by skunk cabbage leaves and cinnamon ferns are a box turtle and several red efts, the land stage of the newt. An oriole perches in the red maple, and a yellow-throat sits on a nearby alder bush. These bushes may be used later as a place for the yellow-throats to build their nests. Stratified glacial deposits form the bank of the lake, and on such glacial ridges the chestnut oak, white birch, and hemlock grow plentifully. Great clumps of cattails with last year's distintegrating flower heads occupy the shallow water, and at their roots, in the protection of the lake bank, a school of young catfish is carefully attended by the parents. In deeper water a yellow perch and a pickerel lie among the yellow water lilies, while a crayfish crawls over the club-like rhizomes of the lilies. Muskrats have built a house of cattails, and one of them may be spotted at the border of the lake making a meal of the tender young plants. Nearby is a bullfrog. A painted turtle on a log is ready to plunge into the water at the first sign of danger. In the distance a marsh hawk sails along and close at hand a redwing blackbird sits on an old cattail stalk. A Virginia rail threads its way among the clumps of cattails. Dragon flies and damsel flies, that have spent their larval stages in the water, now perch on the vegetation using it as a lookout for food. Water beetles swim about in the water where they forage for insect life. Turning again to the central portion of the exhibit we see a screech owl in the oak tree where he awaits the darkness of night to start on his hunting expeditions for mice. A ring-necked snake and salamander are looking for insect food. In the soil profile below the sandy ridge is the tunnel of a wolf spider waiting for prey.

Every living thing over a long period of time has become adjusted to survive in a particular habitat. The picture below, a detail of the scene at left, shows a school of young catfish carefully attended by parents.



Energy from sunlight is used by plants to build basic food chemicals into complex substances of living matter. All other forms of life obtain their energy by consuming the food thus produced. Bacteria in the water act on all refuse and dead remains of life thereby releasing basic food substances which are thus again made available to plant growth.

Cycle of Nutrition and Decay in Water

As on land a cycle of growth and decay takes place in water, where all animals and plants depend on nutritious materials that are either washed in, or come from the decay of other organisms already in the water. Small crustaceans and other forms of animal life that eat aquatic plants serve as food for small fish, and eventually these in turn support larger ones. Crayfish, snails, and other scavengers tend to break up the decayed bodies of organisms, and nutrient materials are set free to be finally distintegrated by bacteria. As in the soil, end products, such as ammonia and nitrates, again become available to plants thus starting the cycle over. The exhibit shows some of the microscopic animals and plants as if seen in a magnified drop of water.

Just as great changes take place in the soil according to seasons, there are also changes in the water due to freezing temperatures. If water froze at the bottom of the lake, fish and other life could not exist. A peculiar characteristic of water is the fact that its greatest weight is at a few degrees above the freezing point, so that this unfrozen warmer water tends to sink to the bottom of the lake in winter. The ice, which is lighter, forms at the surface.

Seasons in the Woods

In the woodlands the seasonal changes are even more noticeable than in the water. The winter seasons, with freezing temperatures and a blanket of snow, prevent growth of most plants. Because of cold winters in temperate regions tree buds have thick scales, but such heavy bud-scales are lacking in tropical trees. Spring is a season of light and warmth in the broad-leafed woodlands. Sunlight passes through the bare branches and heat is reflected from the leaf-strewn ground. The herbaceous plants of the forest floor rapidly put forth flowers, but the flowering period lasts only until the trees expand their new leaves and cut off the light. In the summer season, the leaf canopy cuts out the sunlight and the forest is cool. Most spring herbaceous plants have disappeared from sight, and they will remain in the ground in a resting stage until next year. In the autumn, when more light filters through the woodlands, asters and goldenrods begin to flower. Many fruits and nuts ripen in this season and provide food for birds and other animals.

Insects are responsive to seasonal changes and reach maturity at definite times, according to species. Many pass the winter in the cocoon or pupal stage, but there are exceptions. The mourning-cloak butterfly, which seeks protection behind a loose piece of bark or in other debris, remains in the adult stage through the winter. Similarly the woolly-bear caterpillar, which is shown in the introductory group, remains a caterpillar through most of the winter season.

Changing Forest

In addition to seasonal changes in the forest, progressive changes in vegetation take place over longer periods of time, as is the case when trees come in to occupy abandoned fields. Such changes known as "plant succession" are due primarily to competition between individual plants. The rate of change, and of species which enter the succession, vary with the type of soil and climatic conditions. Many of the successional changes are associated with man's clearing of the forest and cultivation of the soil. The successions on limestone are quite different from those on shale. In the limestone region the abandaned field becomes gradually covered with grasses, dandelions, and other herbaceous plants (i.e. plants that are not woody). Birds carry in seeds of wild apples, hawthorns, and red cedars and these gradually grow up into thickets which are often dominated by the red cedar. Then shade-tolerant trees of short life-span, such as the hop-hornbeam, encroach from the open forest at the margin of the field. Gradually all these trees will be submerged by the permanent or climax forest which in this limestone locality consists mostly of white oak, red oak, sugar maple, ash and basswood. It is a probability that in the future the entire hillside will be covered by a tall forest composed of these trees.

On shale rock an entirely different succession takes place. Buff-colored patches of beard grass soon become abundant on the once-farmed slopes. Then sweet-fern and fire cherry often appear. The sweet-fern shrubs grow in peculiar circular patches. Sweet-fern grows in poor soil, and the farmer knows that such land is not advantageous for agriculture. Scrub oak, gray birch, wild cherry and aspen appear as the next stage of succession. These

will finally be submerged by a mature forest of red, scarlet and black oaks, pignut hickory and red maple.

After forest fires, a different type of succession usually occurs. The blackened humus is invaded by seedlings of aspen and fire cherry. Northward, the purple bloom of fireweed often covers the ground for acres. Fire cherry and aspen are trees of short duration which will eventually be overtopped and shaded out by the oaks, maples, ashes, and conifers which come in to form the mature forest. A transition zone from the richer limestone to the poorer shale appears in this exhibit. Birds such as the indigo bunting, towhee, and many kinds of insects live in the grassy thickets which represent intermediate stages of succession.

The Primeval Forest

The Settlement—1790

The High Tide—1840

Man and the Land

Great changes, typical of our country's growing population, have been brought about by man. This is evident in the Stissing Mountain area. The Indians, with their primitive tools, cultivated only a small percentage of the land and this cultivation had but little permanent effect upon the forests. The white man, entering this area about 1700, brought the steel axe, the plow, and other farm machinery. These enabled the settler to cultivate large tracts of land.

As new settlers came to take up homesteads, there followed a period of agricultural expansion. By the 1840's most of the land, both good and mediocre, was under cultivation. When the rich lands to the west of the Hudson River were opened up many settlers moved away. The result was the abandonment of much of the mediocre shale-land which in the course of a half century had been stripped of fertile humus covering. These abandoned lands grew up into thickets and secondary forests in successive stages similar to those mentioned in the previous exhibit.

The growth of New York City and improved transportation methods encouraged the development of the dairy industry, now the chief occupation of this countryside. A gradual evolution of farm machinery has been constantly taking place. With a tractor a man can accomplish much more than with several of the clumsy horse-drawn plows or harrows or hay cutters of the past century. With strip-cropping and contour plowing and careful tending of woodland, the farms and forests of the landscape may again be brought back to their best possible condition. However, due to man's destructive use of the land, such as over-cropping and the cutting of protective hillside forests, the resulting soil erosion has been such that the full reclamation of these lands will not be possible for many generations.

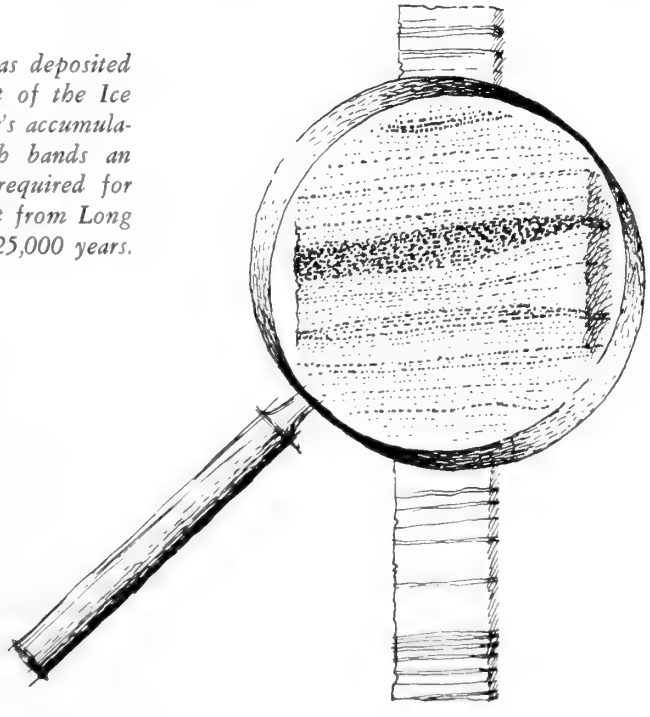
The Ebb—1870

Today

Records of Time

We have discussed the changes of the seasons and the longer period required by plant successions and man's use of the land. An additional series of records is to be found, intermediate in time, between these changes and the vast stretches of millions of years described in the introductory geological exhibit. These are the records left in peat, clay and wood in the period (approximately ten thousand years) since withdrawal of the ice of the glacial period. The vast number of lakes, for which New York and New England are noted, have resulted mostly from barriers of sand deposited as the ice melted. These lakes are gradually filling in, and many people often remember small lakes which have become completely covered by vegetation. This occurs when mosses and associated plants, growing in from the side, gradually engulf the lake to form a bog. These bog plants are eventually succeeded by shrubs and then forest trees. Such bogs, under acid water conditions, preserve root fragments and pollen grains for centuries. Borings may be made as much as 40 or 50 feet in depth, and the core which is taken out shows the history of the bog. Various kinds of pollens found at different depths are identified with pollens of existing trees, of which the climatic requirements are known. In this way changes of climate during the past 5,000 years are in the process of being understood.

Clays, left in fresh-water glacial-lakes by the melting ice, also provide an idea of annual climatic variations. During the summer a rapid melting of snow and ice resulted in the swift run-off of water which carried with it coarse particles which were ultimately deposited on the floors of valleys and lakes. This process was retarded in winter when a greatly reduced



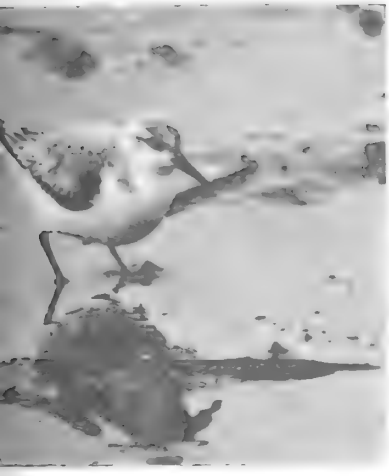
Clay from Hudson, New York, was deposited in Lake Albany during the retreat of the Ice Sheet. Each band represents a year's accumulation of clay. By comparing such bands an idea is obtained as to the time required for retreat of the continental Ice Sheet from Long Island to Central Labrador, about 25,000 years.

run-off carried fine clay particles which came to rest above the coarse particles deposited the previous summer. In this way a band or layer was deposited for each year, which can be counted and correlated much as the annual rings of a tree. By correlating the banding from clays of adjacent river valleys, a good idea is obtained of the time required for the withdrawal of the Ice Sheet.

Tree-rings are also indicative of climatic variations. A slow growing chestnut oak, cut recently at the summit of Stissing Mountain, shows 107 annual rings. Differences in width of rings indicate some of the climatic changes which have occurred in the intervening years. In The Hall of Forests the great section of California redwood shows 1341 annual rings. This provides a far better record of climatic changes.

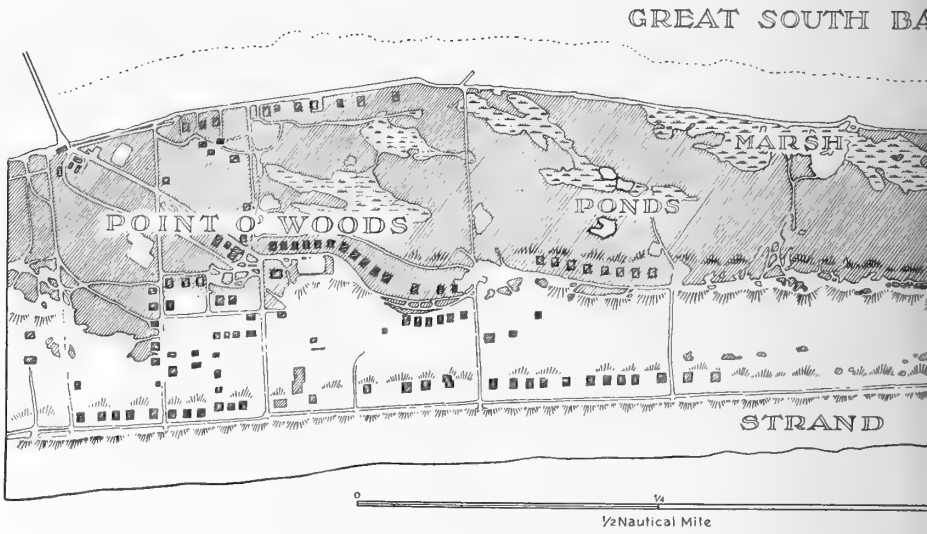
The Felix M. Warburg Memorial Hall of The American Museum of Natural History provides an excellent opportunity for both the rural and city dweller to acquire a better understanding of the country landscape, to appreciate its complexities, and to learn how its appearance has been the result of centuries of continuous change.

AUGUST ON FIRE ISLAND BEACH



BY
ROBERT
CUSHMAN
MURPHY

AUGUST ON FIRE

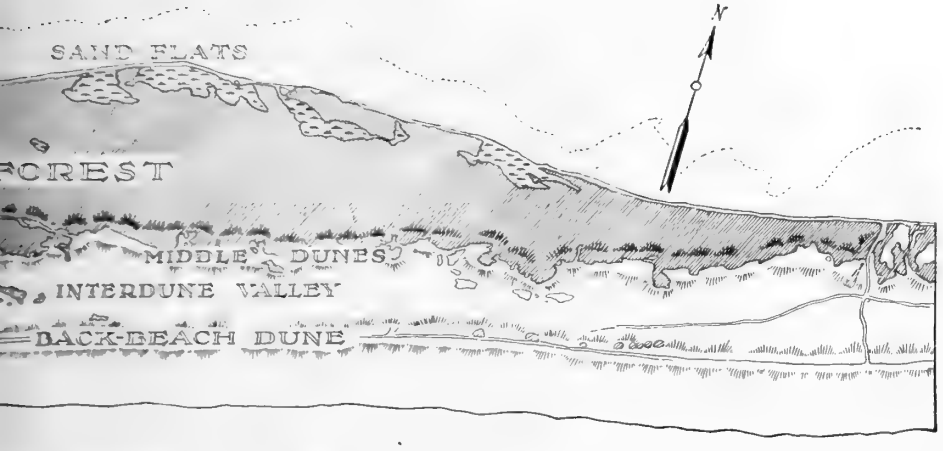


BY ROBERT CUSHMAN MURPHY

SCIENCE GUIDE No. 134

THE AMERICAN MUSEU

SLAND BEACH



F NATURAL HISTORY...NEW YORK CITY...1950

A.M.N.H. photo

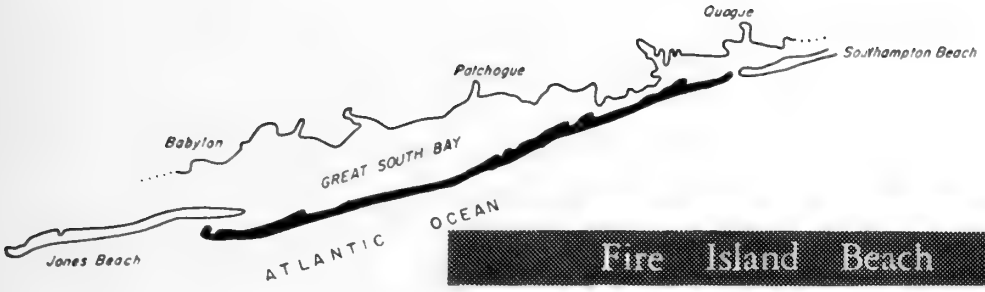
EDGE OF THE BAY

Clumps of shadblow **(Amelanchier),** and their drowned stumps below the present strand level, are characteristic of the quiet bay shore.

A.M.N.H. photo

DARK, DAMP, AND BOSKY DELLS

From the bright, seaside glare atop the dunes one can plunge among gnarled hollies where twilight prevails, and where the bottoms of depressions are muskeg.



Fire Island Beach

One by one, most of the barrier beaches off the south shore of Long Island have been joined with the mainland by track and motor causeway across the creeks and meadows. That this has resulted in the greatest good for the greatest number can be doubted by no one who spends a day in the Jones Beach State Park. From here westward to Coney Island, mankind's appropriation of the ocean front has been in varying degree completed, the product likewise varying according to the motive, aim, and taste responsible for the growth of each section.

East of Fire Island Inlet, however, lies a summerland that is still frontier. The longest continuous reach of barrier, the natural breakwater between peaceful lagoons and the Atlantic, Fire Island Beach extends—mostly roadless, trackless, isolated, and alluring—for twenty-five miles to the Moriches Inlet. Thence under other names it goes on toward West Hampton, where the bays narrow and where for the first time one finds thoroughfares leading from sand to soil. Settlements, small and far between, dot the beach; nevertheless, much of it remains as if in unworldly trance which began in the time that the Indians vanished, and which now stands in danger of an unhappy awakening whenever the rush of "development" arrives. The beach has infinite solace for body and soul; it affords not only the usual charms of an unspoiled seashore but also provides features so rare in our northern latitudes that they are in the nature of wonders. It is high time, therefore, to take counsel and to plan. The larger the human population destined to make use of Fire Island Beach, the more urgent it becomes that the face of nature be kept with as much as possible of its pristine complexion, instead of being first blemished and afterward restored with make-up.

Point o' Woods

On the map, the western end of Fire Island Beach seems very close to the metropolitan area. The tip of it, indeed, has not altogether escaped the curse. But when in August, 1932, I came to Point o' Woods, which is but six miles east of the Inlet, there was a sense of remoteness smacking of Nantucket in the old days. No roads, no motor cars; oil lamps as the source of illumination in most homes; a single telephone, in the Coast Guard station, available to residents for emergency calls to the mainland; supplies and luggage hauled from dock to cottage in toy "express wagons."

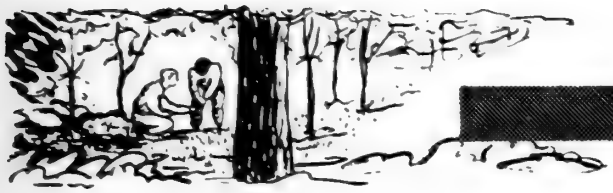
So, almost within the long evening shadows of New York skyscrapers, has simplicity been held fast, while toward the east stretches a wilderness and a land of surprise. The symbols of the outside world may still be within sight and sound. Southward a trans-Atlantic steamship passes, hull down, with stacks looming up enormously; the smoke of a railroad engine, five miles across the bay, climbs the northern summer sky like a thunderhead; army combat planes drone back and forth high above the foam, in pursuit of a towed bag target, and the faraway patter of machine guns mingles with the roar of the surf. But in Point o' Woods, shut off from all distraction by an hour's trip on a miniature ferryboat, life runs its quiet course, and by a ten-minute walk you may find yourself equally alone on a resounding beach, or in a marsh lost amid dense stands of oak and pine, or under the umbrageous gloom of hollies that have a mythic unreality in modern, despoiled Long Island.

The Barrier Beach

Everything south of the terminal moraine on Long Island is outwash plain. It has been built up to a gentle slope with material carried down by rills and streams from the northern ridge, which marks the line of the old ice foot, to the meadows at the landward edge of the south bays. At first that shore was no doubt ocean beach, and this leaves unexplained the extensive barrier that forms the bays and of which Point o' Woods is a part. Just how old the Fire Island Beach and its neighboring counterparts may be, nobody has yet determined. Wave action tends to excavate the same forms beneath the ocean as on exposed shores, and the barrier originated through the breaking in shallow water of rollers too large to travel all the way to the mainland. The movement of sand from these outer breakers to the landward side of the submarine cut produced first a bar and then a chain of islets which eventually fused to form a continuous beach. Its present equilibrium is the result of ceaseless contest; the eroding forces, such as the direct assault of storm waves and the tidal currents between ocean and lagoon, work toward the destruction of the barrier, while deposits carried by longshore wind-made waves build it up on the ocean side. Whether it is now gaining or losing, or even whether the entire beach is moving in the direction of the mainland, is not certainly known. To man, a creature of short life and short memory, the broad area just east of Point o' Woods, with its high dunes, luxuriant vegetation, and aged trees, has all the earmarks of permanence and stability.

A cross section of the barrier where it is widest and most variegated shows five distinct belts between ocean and bay. These are:

1. The strand.
2. The back-beach dune, which is regular and wall-like.
3. The broad interdune trough or swale.
4. The high inner dunes, which are in places double or complex, and which here and there continue in the form of isolated mounds clear across to the bay shore. These dunes may be completely wind-formed, or the main tier of them may represent an older shore line. In any case, they are now well covered with plant growth.
5. Low flatland between the inner dunes and the bay, mostly forested but broken by a chain of marshes. Where the latter abut upon the bay, they become brackish and support some typical salt-marsh vegetation.



The Vegetation

The plant life of the barrier naturally has a distribution correlated with the land formations. In a broad sense, the vegetation is of two sorts, one being made up of true seaside plants, which the botanists call halophytes, the other of the continental coastal plain flora. The latter includes all the trees and even such familiar shrubs as beach plum and bayberry.

On the upper strand, beyond the line of high tide but well within the swash of storm waves, the plants begin. At least six species grow on the stark sand below the cut bank of the first dunes. The rare little coast amaranth here spreads a medallion that looks like glazed and richly colored porcelain. The leafy stems of seaside sandwort, half buried in drift, stand up like elfin pagodas. Gray clumps of the dusty miller, scattered wisps of dune grass, and growths of sea rocket and seaside spurge, complete the list of land plants that go down to meet the spume.

While all seem equally at home on the Fire Island barrier, there is one that is an immigrant and hence could not have been found by any Shinnecock or Poospatuck when the beach was the range of redskins. This is the dusty miller (*Artemisia stelleriana*), a native of the North Pacific coast of Asia, which escaped first from Swedish gardens to Swedish beaches and later repeated the same history in North America. While it is now found in many inland localities, such as the shores of lakes, it thrives most

THE SUN-FLECKED "SUNKEN FOREST"

Youngish holly, sassafras, and tupelo, with prickly bonds of cat brier. The floor is here covered mostly with wild sarsaparilla.

A.M.N.H. photo

abundantly along our Atlantic beaches from Maine to New Jersey, a coast that is the climatic counterpart of its original home.

Climb the bank of the back-beach dune into a new and more luxuriant plant association. Here the dune grass is rank and dense, hiding the blossoming beach peas and scattering seed to the August wind. Extending up the landward slope are many plants most characteristic of the interdune swale, such as the seaside goldenrod, poison ivy, Virginia creeper, and low masses of bayberry. In the swale itself are all the plants yet named, except the few confined to the strand, together with panic grasses, pinweed, saltwort, starry Solomon's seal, wild wormwood, the gray lichens called "reindeer moss," hawkweed, thistles, and shrub growths of red cedar, rum cherry, beach plum, winged sumac, huckleberry, and pitch pine, some of the clumps being bound into thickets with cat brier and other vines. Here, too, the beach heather and the bearberry form solid beds on mounds toward the northern side of the depression, and the bracken curls, rattles, and turns brown in the August drought.

On the inner dunes one meets with vegetation of different appearance or composition from that of the swale. In the first place, plants already noted put on new style. The beach plum, sumac, high-bush blueberry, and bayberry form tall, stout shrubs. Some of the plum trunks are four inches thick. Pine and red cedar lay off their bushy habit and become trees. The crest of the highest dunes marks the edge of a jungle, with close banks of wind-planed holly and post oak, the latter assuming the stunted form of scrub oak, so familiar on the mainland pine barrens. From the dune tops, thirty-five feet or so above sea level, one can see that the roof of the forest in the depression on the northern side has also been planed to general uniformity by the winds. Only more or less gaunt pitch pines project here and there above the flatness.

The slope is abrupt from the high dunes into the sheltered and shadowed land toward the bay. Wherever this northern zone of the barrier is rolling, the vegetation is likely to be somewhat open, consisting of red, black, and post oak, pine, and red cedar, mingled with shrubbery and undergrowth. But in low flats and pockets behind the higher dunes are remarkably close stands of both ancient and younger trees, banked with impenetrable masses of cat brier and bound together by twisted lianas of grape and poison ivy. In Point o' Woods parlance such places are known as "sunken forests." The component trees, in approximate order of abundance, are holly, tupelo, sassafras, rum cherry, oaks, large pitch pine, red cedar, and red maple. The first three form a few groves to the practical exclusion of other trees. In some places, too, the tangle of vines is lacking, and there is a soft carpet of ferns, wild sarsaparilla, and Canada mayflower. The puddle hollows run into muskeg, with sphagnum at their centers. Such spots are doubtless kept moist by seepage from the dunes.

The forest floor is dark with the tough fallen leaves of holly and tupelo, and very little light filters through the canopy above. It is cool and humid in such places, even at summer midday when the atmosphere is scorching on the dunes a hundred feet away and less than forty feet higher. The trees are all rooted in quartz sand, as is apparent wherever a fallen trunk has torn up its foothold, but the surface blanket of mold is fairly thick. In most places one can dig through about six inches of black humus before the grains of sand become appreciable.

The long boles of the trees in the sunken forest make a picturesque and contrasting scene. Most striking are the yellowish-gray hollies—the last word in grotesquerie of stem and branch—twisted, gnarled, and knotted, parting and fusing again like island olives. Cloven trunks are not uncommon. Some of the hollies have diameters of ten to twelve inches, breast-high, and a height of thirty-five feet.

Then there are the gray, mosaic-barked trunks of the tupelos, averaging somewhat smaller, but even more sinuous or crooked—a coastal character rather than one belonging to the species. The oak bark, except that of the post oak, looks black in the dim light. The

A.M.N.H. photo

WIND-BREAK OF THE WOODS

Wind-planed holly, red cedar, pine, beach plum and bayberry mark the ramparts of the inner dunes.

sassafras trees have trunks of a rich brown, and these, particularly in the younger individuals, are also contorted and vinelike from the whimsy of sea winds. Many have diameters of fifteen inches, which is close to the usual maximum on Long Island.

A few of the pitch pines have seventeen-inch trunks, with nine or ten-inch lower limbs. The largest of the red cedars are mostly dead and white, burgeoning toward their tops with the rich foliage of poison ivy, which slays not with its sap but with the more subtle venom of its heavy shade.

Running through this flatland, which averages only a few feet above the level of the water, are the marshes. Most of them open on the bay shore, but others are wholly surrounded by forest. The flora includes cattails, sedges, ferns, cranberry, swamp rose, poison ivy and poison sumac, azalea, swamp St. Johnswort, pink rose mallow, and young pitch pine. Older pine appears to be encroaching upon the margins and is especially thriving upon the needle-covered "island mounds," which are doubtless conquered dunes. The oak woods, likewise, are most luxuriant at the verge of swamps. Sporadic trees of the "sunken forest" association grow right across to the bay, a few good-sized hollies standing within three paces of the present edge of salt water.

There remains a bulk of bushy and shrubby vegetation that fills the space among the trees and helps to frame the marsh-land. This includes many of the species already named. Conspicuous everywhere, moreover, are the tall clustered stalks of shadbush, practically all of which are wavy, unlike inland plants of the same kind. The bark of the shadbush abounds with pits made by the yellow-bellied sapsucker, a fact suggestive of its kinship with the apple. Living clusters are found quite to the brink of the water on the bay side, and many groups of the decayed stumps, together with the bleached skeletons of post oaks, are among the evidences of local subsidence or undermining on this shore. Large clumps of shadbush are, indeed, the principal accent on every little point along the bay, as though the bundles of its roots were a bulwark against erosion by water. Between such clusters, bayberry, huckleberry, sweet gale, beach plum, chokeberry, yarrow, wood sage, Virginia creeper, blackberry, cat brier, the inkberry or smooth holly, and an occasional group of groundsel bushes and stunted oaks combine to make a thicket just above the narrow bay strand, where water plants pile up on the reddish or blackish sand.

The adaptability of some of the barrier beach plants is remarkable. Perhaps the poison ivy is the best example. On dry sand, as in the interdune swale, the plant stands alone as a compact and vigorous bush shrub, with a trunklike stem. On the inner dunes and along the bay, it forms jungle with the cat brier.

In the forest, it is a creeper and climber, running to the tops of the tallest trees and there sending out strong horizontal branches; in the swamps, a trailing ground vine, bearing slender, upright standards among the sedges and reeds. Although no friend to man, it is a successful and beautiful plant, ready for competition with all comers under every condition of soil, moisture, light, and even saltiness. Before August is old, it begins to unfurl a red banner, thus joining with the sumac, tupelo, and sassafras as early heralds of autumn.

Doubtless a word should be added about the eelgrass (*Zostera*), which is a plant both of the bay shallows and of trenches off the ocean beach. It is not an alga but rather a terrestrial flowering plant gone maritime, and a member of the pondweed family. Large areas in the bay that formerly supported dense growths of eelgrass are now bare, and on all hands one hears of a marked shortage in Great South Bay, as elsewhere along the coast from New England to the Carolinas. The fact has a serious bearing on the economy of many creatures, from shellfish to wild fowl.

Flotsam and Jetsam

The Fire Island ocean beach is made up of pure quartz grains mixed with shell fragments; pebbles are extremely scarce. The daily contour of the lower strand varies according to the direction and force of the wind, and the nature of the organic material cast up leads me to the conclusion that a careful and prolonged record of the jetsam, as correlated with meteorological conditions, would be illuminating.

From this point of view it is clear that the ocean is selective, not haphazard, with reference to what is washed ashore. Thus, on August 21, when the weather had moderated after two days of strong southerly winds, with high surf, the line of wrack was marked with countless bunches and strings of seed mussels. Most of them were attached by the byssus to threads of seaweed or bits of shell, but others were joined together by a rope made only of the byssal fibers. The individual shells were half an inch in length or less, but the tide line was black with them for miles. Doubtless the preceding surf days, with many successive lines of breaking waves, had scooped them from their moorings.

Earlier during the month, and I believe after periods of gentle southerly winds, the principal flotsam on certain days had been the disks of jellyfish, as round and clear as magnifying glasses, or, again, the gelatinous clusters which resemble water-logged chrysanthemum blossoms and which are the egg masses of a squid. Still again, attention would be fixed by vast numbers of the shells of the sea clam, mostly immature examples, many of them drilled by carnivorous snails. The shells of the snails were sometimes mingled with those of their victims, but the sand collars, which are the snails' manufactured egg cases, usually appeared on the beach at other times, when they, in turn, formed the preponderating element of the jetsam. On August 29, following twenty-four hours of northerly winds, the drift was composed mainly of young rock crabs, tens of thousands to the mile. The point of these random and inconclusive observations is merely to emphasize the fact that on any one day some particular organism, rather than a miscellaneous aggregation, makes up the conspicuous spoil of the sea.

Referring again to the sea clams and drilling snails, the latter are cannibalistic as well as merely carnivorous. The victims of their own

kind always have the hole in precisely the same position, on the convex surface near the whorl. Evidently the predator thrusts its foot over the whorl and operculum of its prey, taking the position in which it "fits" most conveniently, whereupon the grinding radula works always against the same spot of the shell. In a similar way, the clams are invariably drilled on the convexity of the valve, in a middle position close to the hinge. In such reactions we see the simple and understandable beginnings of more complex and mysterious phenomena, such as the ganglion stinging of the spider-killing wasps.

Many shells of both clams and snails show that the boring process had been interrupted before completion, leaving polished circular depressions exactly the size of the holes through which other mollusks had been eaten alive.

Following long-continued southwesterly winds, garbage occasionally floats ashore, to the shame of a backward metropolis. Bottles, here as everywhere else, seem to make up the principal harvest of the modern ocean. What perverse sense of neatness decrees that every cork and stopper should be carefully pressed or screwed into place before they are cast overboard? If it were not for that habit, they might pave the bottom of the deep instead of strewing the beaches by millions. I wonder whether hand-blown bottles, George Washington and pistol flasks of a former century, lie buried deeply under the bases of the first dune! Among thickets of the inner dunes I found bottles that had perhaps lain at the surface for many years; through the effect of sunlight upon the manganese in the glass, they had acquired the well known purplish opalescence of bottles long burned by the glare of deserts.

The Turbulent Life of the Sand Bug

Step into the wash of the surf, and you may find yourself startled by the semblance of a hundred half-seen whiskered faces peeping up from the bottom. Then, within the twinkling of an eye, the curtain of seething water streams back to sea and blots out the vision. By the time the torrent of gritty foam has gone, leaving the wet slope bare, there is no sign of life. Was it fact or fantasy? Before you can investigate further, the wreck of the next breaker swirls up, and the bottom is again lost beneath a foot of froth.

Now change your position a few paces along the beach. Stand quietly where you will be ankle-deep when the swell is half sucked back. Once more, "as through a glass darkly," bristly visages stick out of the surface of the sand that a moment before had seemed bald as an egg. Where the streaming is swiftest down the incline, you may even see the rotund bodies behind some of the faces torn from their anchorages and whisked pell-mell toward deeper water, only to vanish magically as soon as they touch bottom. A mad and riotous life it is, whipped and rolled and mauled by waves that never cease.

What are these teeming creatures? Rocky coasts, we know, swarm with kaleidoscopic life, but any naturalist will tell you that the lower strand of sandy beaches and the waters inside the outer breakers have no great variety of beings large enough to catch the eye. Rather, this joint strip of earth and brine forms more of an ocean graveyard than an environment for the living. Yet at least one astonishing animal fills the sand in numbers beyond imagination, however much its way of life may hide it from the casual observer. The mysterious beastie is the sand bug, or hippa, a crustacean technically known as *Emerita talpoida,* which

might mean—if zoological names may be said to mean anything—"the mole-shaped one who has served out his time." Whatever their name or antiquity may be, the sand bugs, as Professor Leidy once remarked, are as thick in their proper habitat as currants in a plum pudding!

The sand bug has a range tens of thousands of miles in length and ten yards—or it may be only ten feet—wide. Those you find along the shores of other oceans than our own North Atlantic may be first or second cousins of the kind that dwells on the beaches of the Carolinas or Fire Island or Cape Cod, but you would need a very dull book and a lens to tell any of them apart. To all intents, one and the same hippa occupies most of the world's temperate and tropical coasts, except those of Europe. In many places, such as India, Madagascar, Peru, Florida, and California, the sand bug has been used from time immemorial as food for men. Indeed, it was by watching Indian fishermen on the broad, shining strands of Peru, where the creature is known as the *mui-mui,* that I first became acquainted with it, long before I learned that it frolicked practically in my own dooryard on Long Island. But wherever you find it, its bailiwick is always in sandy beaches sluiced by waves from the open sea, and it leads the most turbulent life of any denizen of the great waters.

Now, for the sake of prying more deeply into the ways of this odd little neighbor of our bathing beach, let us scoop with both hands under the backwash and run ashore. Plop the load down on dry sand, and a half dozen or more of the sand bugs may roll out, either to lie still as though dead or to scuttle off backwards with the movements of miniature war tanks, quickly orienting themselves to a course down the slope. If the spot is level, or even inclining slightly away from the water, they may appear puzzled for a few moments. However, under such circumstances, another reaction quickly takes the place of the one affected by gravity, for the tiny tanks will presently turn themselves and head, or rather "tail," directly for the ocean. A little experimenting with the stranded victims will prove that their primary directional responses, when they find themselves out of water, are two, and that these are more or less balanced one against the other. The first of them is related to slope, or geotropic; they like to run downhill. The other is related to the source of strongest illumination, or phototropic, that is, to the glare of the sky above the sea. Either of these instinctive responses would tend to save their lives if they chanced to be cast high and dry. But a sharp slope away from the water fools them and poses a problem. In this case they soon demonstrate that the geotropic reaction is stronger than the phototropic; they forget the bright sky offshore, alas, and follow their weight downhill in a direction that will do them no ultimate good.

On dry sand they are, perforce, creatures of the surface and must grope their way as best they can toward the water. But if you place one of them on sand well wetted by the last wave, you may at the same time say "Goodbye!" You will just have time to see the sand bug tip up its snout and vanish hind-foremost, leaving scarcely a dimple to mark the spot. "Sand mole" would be a more appropriate name. In a quart glass jar filled with water above three inches of sand, one of them will swim and tunnel its way to the bottom within a second.

The females of the North Atlantic sand bug are about an inch in length, the males a third smaller. During August most of the females carry under their tails orange egg masses, in some of which developing embryos are visible. The smooth, rounded carapaces of the creatures are of a sandy color, tinged with pinkish. Their bodies are shuttle-shaped and when snugly folded up, they show rather less in the way of protruding members than a "blimp." All appendages, in fact, tuck away securely, leaving a perfectly streamlined exterior, but each pair has, nevertheless, its special function in locomotion and feeding. Thus, while the hindmost are stirring the sand and scooping it outward, during the burrowing process, other jointed limbs are pushing and paddling the body into the hole it makes as it

goes. When excavating, the sand bugs always work against the prevailing current, with the useful result that each runoff of the waves leaves them facing seaward as they stand nearly upright in the sand, with only the eyes and antennules exposed. Ceaseless activity is necessary for retaining their positions, for with each wave the topmost layer of sand is transformed into a fluid and every solid object near the surface is undermined. Their existence is like that of a trapeze acrobat who never stops performing.

The inefficient-looking eyes of the sand bugs, mere spots at the ends of threadlike stalks, must serve their purpose well in warning their owners of shadows or of large opaque dangers such as curlews, gulls, or men. Certainly the tufted faces withdraw and leave no trace within an instant after you have darkened their hiding places.

Little neatly folding doors of the mouth parts as well as the anterior limbs of the sand bugs, protected along their edges by bristly hairs, serve to keep the sand out of their mouths and gullets while the incoming wave is bearing up their next meal. Up to this point they remain shut as tight as a chest. But as the water starts back, two long curved flagella lined with hairs, like the feathery antennae of a moth, are whipped out from within the doors. It is these structures that give the sand bugs their bushy-snouted appearance and that also make the tiny V-shaped ripples in the sand which, in tranquil weather, give the first inkling of their presence. As the water rushes through the finely fringed flagella, microscopic organisms, both plant and animal, such as diatoms, radiolarians, and foraminiferans, are entangled in these fish nets. Then, in the calm moment while the wave is out, the nets and their contents are drawn once more behind closed and locked doors, and during the subsequent inrush of the surf the happy sand bug scrapes off and swallows its meal.

The active life of the creatures is the brief period of the backward wave, when they hang on for dear life with one set of appliances and gather in their subsistence with another. During the less devastating influx of water that follows, they find opportunity to enjoy the fruits of their toil. Like the human heart, the sand bugs take all their rest between beats. Swimming, burrowing, or perambulating, moreover, they go through their existence tail-foremost. *A posteriori* beings they are, indeed, for they may be said to reach every conclusion backward!

NOW YOU SEE HIM, NOW YOU DON'T!

The sand bug on the left is in the middle of its fadeaway. The other is just beginning to sink its picks and shovels.

A.M.N.H. photo

Beetles and Biters

No doubt the total insect fauna of the Fire Island barrier is a rich one, but many species are inconspicuous and many are there by accident rather than by choice. The insects most easily seen, I judge, are highly seasonal. In late summer there is certainly no trace of the huge number and variety of beetles to be found along this same beach during June, washing ashore and crawling up the sands like shipwrecked mariners. Only a few cicadas and katydids among the woods and dunes are reminders that August is the peak of the social season for insects on the mainland. Small black and yellow wasps whisk and stamp about, making the sand spray from their feet; pale grasshoppers flutter down to the upper strand from the grassy places behind; and toward the end of the month the migratory monarch butterflies begin to pass, westward bound, sometimes flying against fairly strong breezes.

During northerly winds there is abundant evidence of the presence along the ocean shore line of hordes of small insects that cannot be discerned by the eye. This is indicated by the habits of swallows and chimney swifts which, at such times, hawk back and forth over the wash of the waves and the breaking surf. It seems as though a veritable wall of wind-blown insects must be struggling to regain the land along this line, for under other weather conditions the birds never forage in the same place.

Northerly winds are, fortunately, rare on the barrier in summer, for it is only when such are blowing that mosquitoes and biting flies make a sudden and dire onslaught. Once, after three days of breezes off the land, the so-called stable fly (*Stomoxis calcitrans*)—an insect which gives the housefly the quite undeserved reputation of biting before rain—made the strand practically unendurable to human beings. This species breeds in decaying vegetation and is found the world over. It can bite through summer clothing or woolen stockings as effectively as on bare skin. On "mosquito days," huge dragonflies gather in flocks along the Point o' Woods paths, darting about on their beneficent quest.

Another and well known effect of offshore winds is to lower the temperature of coastal ocean water. Southerly winds in August may be accompanied by swimming temperatures

A MIGRANT AMONG INSECTS

A large proportion of the brown monarchs seem to follow the Atlantic beaches on their southward travels of summer and autumn, from which the same butterflies never return.

A.M.N.H. photo

TIGER OF THE STRAND

The beach tiger beetle is a prowler and predator among the smaller inhabitants of Fire Island. Its movements afoot seem even quicker than those a-wing.

A.M.N.H. photo

up to 70 degrees F. or higher, the figure rising to a maximum as the offshore surface waters are blown on the coast. Twenty-four hours of winds from a northerly quarter, however, are sufficient to cause upwelling in the sea and to lower the thermometer to 58 degrees F., while at the same time extremely warm water piles up along the opposite or bay side of the barrier. Possibly these temperature changes in themselves have something to do with the movements of such strand insects as the common cicindelid beetle.

Very typical among the Fire Island insects is this predacious tiger beetle (*Cicindela hirticollis*). It makes active short flights along the hot sand and is said to prey chiefly upon other insects. Most of the creatures I found in the territory over which it prowled were minute, leaping sand fleas, but never was I able to prove that it captures these crustaceans. The gray and bronzy *Cicindela* moves to windward, and, though it ranges to the waves' edge, it shows a strong reaction against being carried over water by the wind. This can be demonstrated by keeping on the windward side and badgering the beetles with handfuls of sand, thus driving them gradually down the beach. They prove wary and artful dodgers, and, even when fatigued by continued barrages, they still contrive to work away from the water. The same reaction is shown under natural conditions when high winds and drifting sand herd them willy-nilly toward small points, with rills of tidal water to leeward, for here they cling in bands, showing great reluctance to cross even a few yards of water to the farther shore.

The tiger beetles are, consequently, most numerous on the ocean beach when the wind blows from the sea, and during days of northerly breezes they are scarce, if not absent. On August 20, after several hours of light northerly winds, I discovered what takes place and confirmed the observations on several later occasions when stronger offshore winds were in progress. At such times, the beetles carry out their windward tropism to the extent of crossing the barrier beach en masse, flying over or through the forest belt and concentrating along the very narrow strand strip of the bay, where they may come to number a score on each square yard of surface. On August 29, with the wind from the land, and bloodthirsty stable flies attacking the very heads of swimmers in the cold ocean waters, not a tiger beetle was to be found on the sea beach. But on the bay side they were legion. They were hunting jerkily among very small, soft-bodied sand flies, which they appeared to capture during quick bursts of walking, rather than in flight. The short darts they were forever making over the blackish sand were so rapid that the eye could not follow them or, at least, perceive the result.

Lowly Vertebrates

Toads, mostly young, were the only amphibians I found on the Fire Island barrier. Ever ready to take advantage of them is the principal local toad-eater, the hognose snake. Formerly abundant along the south shore beaches, the hognose is now scarce because of man's stupidity. Despite puffing and bluster, its gentleness and infantile expression due to the retroussé snout give it a peculiarly inoffensive look, except to the hopelessly prejudiced. It is one of the few snakes that cannot possibly be goaded into biting or striking. Its overt acts, indeed, are confined to swelling up and to playing possum; at all ages it is a safe plaything for babies. The only other reptile I encountered was a single black snake among the inner dunes.

Birds of Sea and Barrier

Owing to the absence of salt meadows and large ponds on the part of the barrier near Point o' Woods, the region is not favorable for observing a great variety of migrant snipes and plovers, which would quickly swell an August bird list. During about twenty days' residence, I saw sixty-six species of birds and clear traces of several others (such as the signatures left by the sapsuckers during their spring and autumn tarrying).

August is the moon of molt and silence for most land birds, which increases the difficulty of discovery. Even such famous advertisers as ovenbird and redstart are then voiceless in the "sunken forests" and must be seen in the half-light to be known. But August is also the month of fledglings, which partly compensates. Birds with the unmistakable marks of childhood, whether of plumage, notes, or manner, were everywhere, some still in tow to their elders, others already at the stage of independence. They included the green heron, black-crowned night heron, marsh and sparrow hawks, common tern, kingbird, all the native swallows save the rough-winged, chickadee, catbird, brown thrasher, robin, black-and-white warbler, yellow warbler, northern yellowthroat, ovenbird, redstart, red-winged blackbird, cowbird, towhee, and song sparrow. All but about seven of these, namely the night heron, sparrow hawk, and the swallows, may well have been hatched on the Fire Island barrier, as may likewise such others in my list as the least bittern, bobwhite, piping plover, spotted sandpiper, black-billed cuckoo, ruby-throated hummingbird, kingfisher, flicker, hairy woodpecker, crested flycatcher, wood pewee, blue jay, crow, Carolina wren, cedar waxwing, and Baltimore oriole.

Several of the resident song birds were of more than passing interest. A pair of Carolina wrens, for instance, disregarded the midsummer rule of silence, for their singing and rattling could be heard at all hours of the day. The shelter of the "sunken forests," coupled with the tempering influence of the ocean, makes an ideal environment for this Carolinian bird. It is a sedentary species that extends its range and numbers in the north throughout a series of years, only to be more or less wiped out by the first bitter winter. One would suppose, however, that Carolina wrens and hollies might exist together indefinitely in such a habitat as the barrier.

The abundance of the catbird throughout the whole wooded area of the beach is a revelation. Nowhere else have I seen such dense population approached. Here the species evi-

MASCOT OF FIRE ISLAND BEACH

Although only a transient shore bird, the sanderling outnumbers all other species along the tide line and can be found during more than half the year.

Photo by Allan Cruickshank from National Audubon Society

Photo by Allan Cruickshank from National Audubon Society

AT HOME IN THE THICKETS

For the catbird, the tangles of interdune trees, shrubs, and lacing vines make an ideal habitat.

dently finds optimum conditions. The territories of the mated pairs must be extremely small, for in August a catbird was almost invariably in the picture wherever one looked among the trees and brambles, and the plaintive, susurrant whistle of the young was an unfailing forest note from daybreak until dark. On August 13, my younger son and I made a count of catbirds on a stroll between the Point o' Woods post office and the eastern end of the first forest patch, about half a mile west of Cherry Grove. With little or no chance for duplication we checked off sixty-three.

The song sparrow made one of a trio with the towhee and Carolina wren to keep in full voice all through the dog days. It nests closer to the ocean than any other land bird, building sometimes in beach plum clumps on the landward slope of the outer dune. Adults were carrying bills full of food to late broods until the very end of August.

Of the transients, the most entertaining, perhaps, was the migrant shrike, a bird that may be said to travel by telephone, because the coastal wires seem to be its route all the way from New Brunswick to the southland. From one pole to the next it skips by easy stages, yet rarely interrupting its journey for a longer stay than the time necessary for pouncing upon and devouring a grasshopper. Equally amusing was the sight of northern water thrushes, apparently out of their element, catching small nereid worms on flats left bare by the falling tide of the bay shore.

Of the sea and beach birds one might easily write too much. An adult gannet, bent on breaking records, reached Point o' Woods on August 21, almost as early as the expected flocks of double-crested cormorants. From among the dozen common shore birds, each as interesting as the others, I must restrict my reminiscences to the sanderling, which is by all odds the mascot of Fire Island beach. Well is it called "surf snipe," for the edge of the wash is where it spends its life. The prey for which it picks and probes is no doubt mostly diminutive. I had supposed that its bill and small mouth were adapted only to such food, but one day I frightened several birds into dropping the carapaces of hippas as big as their heads. They had pulled out the meat of these crustaceans, which are as round and tough as an olive. From this I suspect that the sanderlings had also plucked out the bright eyes of a sea horse found high and dry, but still wriggling, at a spot from which they had just flown.

The sanderlings appear to be of two sizes according to whether their plumage is carried sleekly or whether the scapular feathers are raised. The latter mannerism they retain for long periods, giving themselves a fat, humpbacked appearance. Indeed, when most of their plumage blows forward, as they travel before the wind at the edge of the surf, they look for all the world like miniature ruffs. They bicker a good deal among themselves, giving husky whistles as they chase each other, and they

bully the stints and spotted sandpipers at every opportunity.

Sanderlings continue to wet their feet and to hunt for food until late evening, long after the spotted sandpipers have withdrawn to rest among the plant-covered inner dunes where they, alone of the shore birds, were born. The sanderlings appear to snatch their sleep in very short periods during any time of day, usually walking up as far as the first wave terrace for napping. Through glasses I often watched them patter up the strand, turn their bills down their backs, and rest thus for only a fraction of a minute before hastening again to the white water to resume feeding.

While dozing, a few of the birds squat on their bellies and draw down the head, with the bill pointing forward. Many more of them, however, make a pillow of their backs and poise on one leg, which is canted crosswise at a sharp angle to balance the body. In this posture they face the wind and swing like a weather vane as it veers. If they are taken unaware, they seem loath to lower the other leg even after they have turned their alert heads. Rather they are apt to hop on one foot for a few steps, then to stretch one dainty wing, in a characteristic Limicoline yawn, and finally to break into the run that ends with the whole gleaming flock in the air.

Such is a glimpse of the Fire Island barrier, but what an infinitude remains, unlearned, unseen! The proper destiny for extensive areas of the beach would be for them to become part of the New York State Park system, and this as soon as possible, before vandalism and development have destroyed the natural features. The "sunken forests" contain not only the last stands of large holly on Long Island but also the northernmost considerable holly groves in eastern North America, except for one on Cape Cod. Entire blocks that enclose the choicest parts of the forest should be set aside as sanctuaries, with the ecological conditions undisturbed.

Roads, concessions, wholesale clearing of underbrush, or other "improvements" in such sections would be a calamity. Few enough are left of the bits of entrancing primitive territory near New York City. Why should access to the remaining areas be pushed up on rollers, so to speak, to the hordes who allow motor cars to deprive them of the use of their legs and who would never contemplate pulling an oar, or even holding sheet and tiller, across the bay? Why not make all comers welcome, with a modicum of *effort* as the price? Let the hikers, like deer, keep their trails open by healthy use. There are plenty of other routes to be traveled, and bournes to be reached, at fifty miles an hour.

Perhaps if enough of us see the cause in this way, we may yet preserve a part of Long Island in which ancient hollies—and the whole holly association of plants—are granted security; in which the beaches are effectively guarded against pollution; in which faulty mosquito drainage, hitherto controlled mostly by engineers without benefit of biological advice, is never permitted to destroy a large part of the life of the marshes and to drive out the whirlwinds of shore birds that seek to resort to them twice a year during the migration.

On Fire Island Beach it is still possible to maintain the whole environment in proper balance, as Nature intended, thereby enabling us to dwell in the presence and appreciation of the beauty our ancestors found here.

"August on Fire Island Beach" first appeared as an article in the July-August, 1933 issue of Natural History Magazine. The present edition incorporates that original material with new sections and photographs by the author.

[Editor]

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INDIANS OF THE MONTAÑA

BY HARRY TSCHOPIK, JR.

135

THE AMERICAN MUSEUM OF NATURAL HISTORY

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INDIANS OF THE MONTAÑA

BY HARRY TSCHOPIK, JR.
ASSISTANT CURATOR OF ETHNOLOGY

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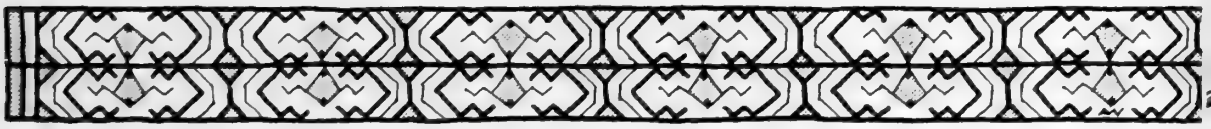

Cashibo warrior.

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TRIBES AND LANGUAGES OF THE MONTAÑA

LANGUAGE AREAS

JIVARO

TUPI

PANOAN

ARAWAK

Introduction

In the dense tropical rain forest of eastern Peru and Ecuador live several related tribes of primitive Amazonian Indians. Their homeland, called the Montaña, stretches eastward from the cloud-covered slopes of the Andes; a region of rugged mountains and swift-flowing streams. In geographical extent the Montaña covers some 233,000 square miles of the Amazonian headwaters, or approximately the area of Arizona and New Mexico combined. Higher in the east than in the west, the altitude seldom exceeds 4,000 feet above sea level, an elevation marking the upper limits of rain forest vegetation.

Accurate statistics on the present Indian population of the Montaña are lacking. The total number of inhabitants of the area at the time of the discovery of the New World, however, probably never exceeded 208,500, or roughly the population of Syracuse, New York.

The rain forest, the mountains, and the rapid rivers have isolated tribes from one another and limited the areas suitable for habitation. In spite of the lush vegetation, soils are poor for farming and game is often scarce. Therefore, before the coming of the White Man, this inhospitable tract of high jungle was inhabited by a number of small, widely scattered, independent tribal groups. During the four centuries that have elapsed since the arrival of the first Spanish explorers, some of these tribes have disappeared altogether, and others are known only from very fragmentary accounts. Today the best known Montaña peoples are the Jivaro of eastern Ecuador, and the Panoan-speaking tribes of the Middle Ucayali River region in Peru.

Discounting minor tribal and regional variations, the culture of the Montaña peoples as a whole possesses a distinctiveness that enables it to be discussed as a unit. Essentially it is a primitive variant of the Tropical Forest culture of lowland South America. Certain characteristic features, textiles and pottery painted in a distinctive geometric style, the oval "Ucayali" loom, coca chewing, and the absence of bitter manioc, set the Montaña apart from the Amazonian culture area. Yet in spite of geographical proximity to the Andes, the Montaña Indians resemble far more closely the far-flung tribes of the Amazon Basin thousands of miles away downstream than they do their more civilized neighbors of the Andean highlands.

The explanation of this situation must be sought in geographical factors, which have had a profound effect upon the growth and development of Montaña culture. On the one hand the lofty mountain ranges and contrasting environments have acted as barriers between Andean and Montaña peoples. On the other, the river systems of the Amazon have served since ancient times as easy routes of trade and communication. Along these vast inland waterways native inventions and discoveries spread quickly from one group to another.

Although the culture of the Montaña tribes has a certain unity that differentiates it from that of other Amazonian peoples, a number of separate and distinct languages are spoken in the region. Some, like Jivaro, Panoan, and the Peban speech of the Yagua, are considered to be isolated linguistic stocks, totally unrelated to other South American Indian languages. Others, like Arawak and Tupi, have a wide distribution throughout the southern continent.

Until the advent of air transportation, the mountainous terrain, deep jungles, and swift, rapid rivers have made the Montaña difficult to access. In pre-Hispanic times, Inca conquest stopped short of the green walls of the rain forest. After the Spaniards arrived in the sixteenth century, brief explorations of the area were made by the conquistadors in search of gold, but few permanent colonists followed in their wake. Until the turn of the century, when the quest for rubber led to the opening of the Upper Amazon, the Montaña tribes were influenced mainly by missionaries, and continued to live much as they had at the time of the discovery of the New World.

Today, however, except in the most remote parts, traditional native life is fast disappearing. For although it is still largely unknown to science and to the public, the Montaña has assumed considerable commercial importance, producing quinine, cocaine, barbasco, oil, and tropical hardwoods. As the White Man's civilization slowly penetrates the rain forest, this last frontier is being opened to modern agriculture and colonization. Unless otherwise stated, therefore, the following pages describe the Indians of the Montaña as they lived about 1900.

Types of graters and strainers used to prepare flour from manioc tubers.

Farming

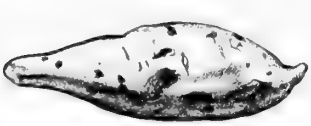
While all Montaña tribes farm, the importance of agriculture varies according to local conditions. Everywhere it is necessary to chop fields out of the living rain forest according to methods known as "slash and burn" farming. Even with steel tools, clearing land under such conditions is a tremendous effort. To primitive man equipped only with stone axes, it was a formidable task.

In making a clearing small trees are felled, large trees girdled, and the entire area is burned over during the dry season. Fields seldom exceed one or two acres in extent, all crops being planted together between stumps and fallen logs. A digging stick is the only agricultural tool. Since fertilizers are unknown, rapid exhaustion of the poor soil requires the constant clearing of new fields, until eventually it becomes necessary to move the community to a new location in virgin forest.

The early European explorers of the Amazon were much impressed with the new and unfamiliar root crops native to the rain forest. Here, instead of cereals, such plants as manioc, sweet potatoes, peanuts, and tuber beans were staples of diet. The latter, *Pachyrrhizus tuberosus*, are cultivated exclusively for their edible fleshy roots, since the beans themselves are poisonous. So well adapted are root crops to the soils and climate of the rain forest that the yam, an Asiatic tuber introduced in historical times, spread quickly throughout the Amazon Basin, where it has become a major crop.

Manioc *(Manihot utilissima)*, the most important of the tropical root crops, has been called "the staff of life of the Amazon." Although the sweet variety cultivated by the Montaña tribes is a major food crop, it is used chiefly to prepare a native alcoholic beverage. Grated manioc pulp is chewed to induce fermentation, mixed with water in a large pot, left in the sun until thoroughly fermented, and finally the brew is strained through a basketry sieve. The resulting liquor is consumed in quantity on all festive occasions. Bitter manioc, our source of tapioca, is not grown in the Montaña.

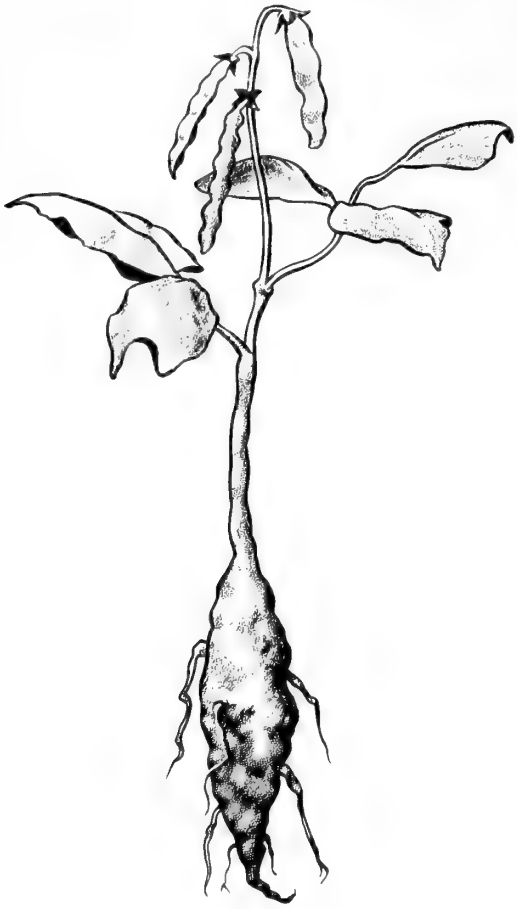
Like most native farmers of the New World, the Montaña tribes cultivate those three famous American Indian crops — corn, beans, and squash. Although corn was formerly an important staple, today it is used chiefly in the preparation of a fermented beverage. The plantain, a banana-like fruit of Asiatic origin, has become the principal food crop in many areas of the Montaña.



Yam

Sweet potato

Peanuts



Tuber bean

Cotton is cultivated by most tribes of the Montaña with the exception of the Campa and Piro, who gather wild species. Both white and brown varieties, used mainly for textile materials, are grown. Since carding devices are unknown, the fibers are carefully cleaned by hand and are then spun into thread on a drop spindle, the end of which is often rotated in a gourd or pottery bowl.

Tobacco, dye plants, and a number of other lesser crops are widely grown, while most Montaña tribes also cultivate bananas and sugar cane, introduced soon after the Spanish conquest.

Cotton supplied the Montaña Indians fibers for weaving. Needles and knives are of bone, while spindles have hardwood shafts and pottery whorls.

Campa fisherman inspecting his nets. The parrot is a pet.

Hunting and Fishing

To some Montaña peoples, fishing and hunting are more important activities even than farming. Although game is never abundant, the clever devices and techniques used by these tribes enable them to make the most of the available food supply.

River animals and fish surpass land animals as sources of meat. Of greatest importance are water turtles and manatee, usually hunted with harpoons and arrows. In addition, turtle eggs are gathered by the thousand during the spawning season. Many varieties of fish are speared, shot with arrows, hooked, taken in nets and weirs, or drugged. The chief food fish of the Upper Amazon is the huge Arapaima, or Pirarucú.

Game animals of the rain forest consist mainly of monkeys, tapirs, peccaries, agouti, and a variety of birds. Snakes and sloths are not eaten, and deer are usually avoided because of the belief that they are reincarnated people. Hunting methods include the bow and arrow, blowgun, and spear, as well as several types of traps and snares.

Montaña arrows are highly specialized and adapted to different classes of game. Those used in fishing have fork-shaped points or barbs of sting-ray spines. Some for shooting larger fish have harpoon heads and detachable shafts that serve as floats. Arrows intended for small game are tipped with thin pencil-like hardwood heads, while big game arrows are heavier and often have lance-shaped blades of cane. Arrows for bird hunting are blunt so as not to spoil the feathers or stick into tree branches.

Most Montaña arrows have hardwood foreshafts cemented into cane shafts with wax or resin, and many are handsomely decorated with tassels and cordage, or painted with red achiote paint. To entice the animals within range of the arrows, the hunter often uses game lures to imitate their calls.

Among many Montaña tribes the blowgun and poisoned dart have largely replaced the bow and arrow for hunting small game. The efficacy of the blowgun depends upon the use of deadly curare poison, the preparation of which is the monopoly of a few tribes. In the Upper Amazon region, the Yagua are especially adept in the manufacture of curare and trade it to neighboring groups. Blowgun darts are made from thin splinters of the midribs of palm leaves. A wadding of cotton or tree silk is attached to the butt to receive the impact of the air puffed into the blowgun by the hunter.

Fish arrow

Small game *Large game* *Bird*

Before shooting a dart the hunter notches the curare-smeared point so that it will break off in the wound, using the jawbone of a piranha fish for this purpose. Extra curare poison is carried in a hollow nut. The maximum effective range of a blowgun dart is from 30 to 45 yards, and several hits are required to kill an animal the size of a peccary. The blowgun is never used in warfare.

The drugging of fish is a common fishing technique in most parts of Montaña. Although a number of different plants furnish suitable drugs, barbasco *(Lonchocarpus)* is most frequently used and is widely cultivated for this purpose. The roots are pounded, grated, or pulverized and dumped into a lagoon or stream, where the stupefied fish soon rise to the surface to be gathered in large quantities. Fish taken in this manner are not poisonous. Barbasco, a native discovery, is commercially important today in the manufacture of insecticides.

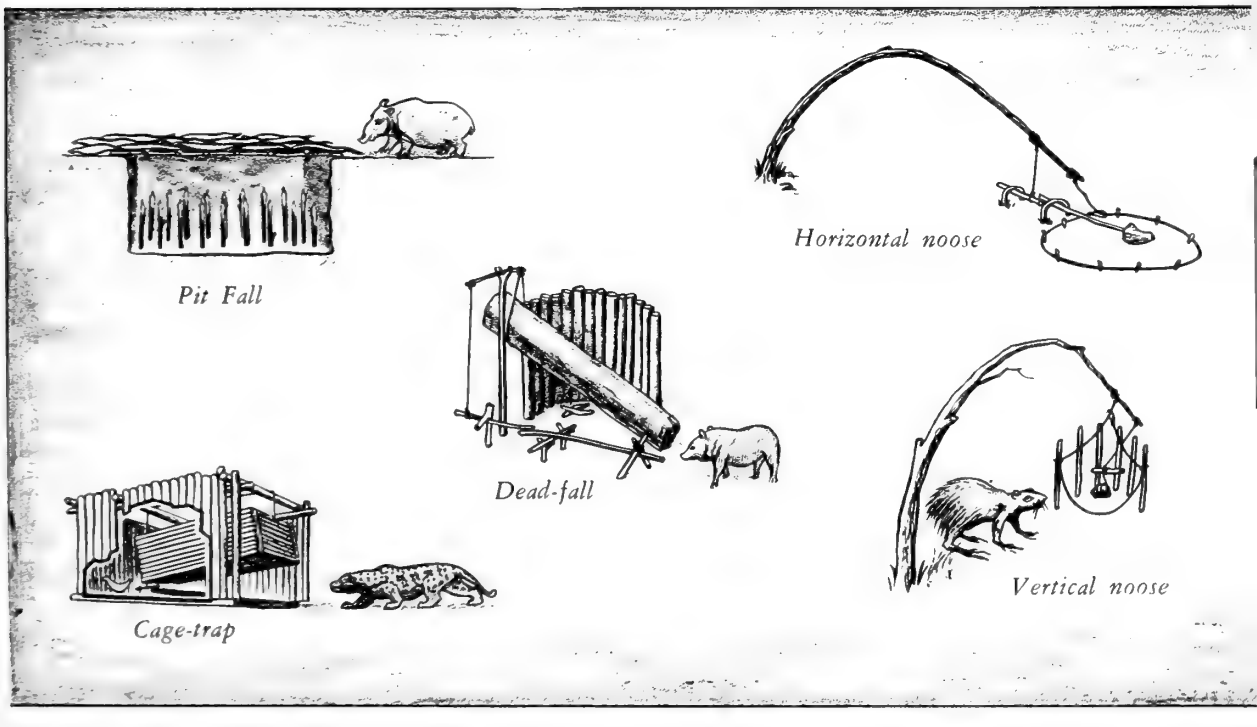
Montaña traps are among the most ingenious hunting devices used by South American Indians. Of the Upper Amazon tribes, the Yagua especially are expert trappers, and show great familiarity with the habits of the animals they intend to capture. Hunters often make small working models of traps, before building full-sized ones in the forest. These are later given to the children for toys.

The pitfall, used mainly for tapirs, is simple in principle, but difficult to construct because of the primitive digging tools. Other traps, like the cage-trap and the deadfall, are complicated in design and make use of delicate trigger mechanisms.

Most tribes use the simple but efficient spring-pole snare to capture small game. If the hunter wishes to take the animal alive, the noose is rigged horizontally so as to snare it by the feet. But in order to strangle the animal, he hangs the loop vertically at the opening of a small picket fence. Racoons, anteaters, and agouti are captured in this manner. The agouti, a wild relative of the guinea pig, is one of the most important year-round food animals in the rain forest, and is snared in large numbers.

Yagua hunter with blowgun.

Blowgun dart case with gourd container for cotton.



Canoe and paddle

River Transportation

The possession of water craft adequate to navigate the Amazon and its tributaries was an important factor in the growth and spread of Tropical Forest culture. Today all Montaña tribes who live along the major rivers make canoes, while even the peoples of the interior use balsa log rafts. In addition to facilitating communication and trade, water craft are necessary for fishing and the hunting of river game.

Dugout canoes, often manufactured of mahogany or cedar logs, are constructed at the expense of great effort. Formerly the hugh trees were felled with stone axes, moved to the river bank on log rollers, and shaped by charring and scraping with stone tools, a process requiring several years to complete. Today steel tools hasten and simplify the construction. Canoes typical of the Montaña are trough-shaped, measuring from 10 to 20 feet in length. Paddles usually have narrow blades and crutch-shaped handles.

Villages and Houses

A typical Montaña community consists of one or a few families, each of which occupies a separate house. Although occasionally five or ten houses are clustered into a small village, the average settlement is composed of from fifteen to thirty persons. Mission influence and the decrease of warfare have, however, tended to increase community size.

House groups and villages are today scattered along the rivers at intervals of a few hundred yards to a few miles. In former times, in order to protect the occupants against attacks and slave raids, settlements were frequently isolated and hidden in the bush.

Most Montaña dwellings are open-sided, thatched-roofed rectangular structures, with or without center posts. These are sparsely furnished with wooden stools for men, mats for women, and platform beds, usually covered with tightly woven mosquito nets. Although their use is ancient in the area, hammocks have become more widely adopted by Montaña Indians since the arrival of the white man.

Model of a Panoan village of the middle Ucayali River region, about 1900.

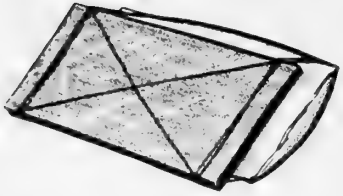
Conibo man and woman in fiesta dress. The large pot contains manioc beer.

Dress and Adornment

The ancient dress style of the Montaña was extremely scanty if, indeed, any clothing at all was worn. Cashibo men were formerly nude, while the men of other Montaña groups wore a breechclout or skirt and, at times, an Andean-type shirt. Women usually wore an apron or skirt. Missionary precepts of modesty, however, led the men of most tribes to adopt a long cotton tunic, or cushma, while women donned pull-over skirts and shawls. The fiber dress of the Yagua peoples is exceptional in the region.

The Montaña peoples show great originality in manufacturing ornaments from the raw materials made available to them by their environment. The plumage of tropical birds furnishes abundant and colorful material for plumes, tassels, headdresses, ear ornaments, and even necklaces. The feathers are either glued to a cane framework, or are tied to netting. Especially typical of the Montaña is the use of whole bird skins, either clustered and tied to the hair, or dangling free from bandoliers and crowns.

From bones, the wing cases of beetles, shells, and even from cocoons, a number of ornaments are made, while the skin, teeth, claws, and fur of animals native to the region supply material for other articles of personal adornment. A great variety of tropical seeds and nuts are used for ornamental purposes, including bandoliers, girdles, crowns, necklaces, and bangles. In addition to those made of native materials, silver ornaments,



Head deformation pads

brass bells, buttons, and especially collars, bracelets, and headbands of glass beads today show influences from the outside world.

Face paint, applied with a bamboo sliver, is used extensively by both men and women, and the practice of blackening the teeth was formerly widespread. Men of all tribes pluck out their beards with shell tweezers, while Montaña women dress their hair with palm splint combs. Both sexes use lip and nose ornaments of wood or silver, and wear earrings made of a variety of materials.

The fashionable head form is flat, high, and broad. This is achieved among the Panoan tribes by means of artificial deformation. For several days or more after birth, the infant's head is compressed between padded boards until it assumes the desired shape. Although this treatment may alter permanently the shape of the skull, it appears to have no noticeable effects upon intelligence.

Wooden lip plug with incised pattern.

Montaña tribesmen painted their faces to harmonize with their clothing.

Model of a Piro woman weaving a poncho on the Andean-type backstrap loom.

Weaving and Pottery

Most Montaña peoples weave long shirts, or cushmas, shawls, skirts, bags, and other wide textiles on horizontal back-strap looms that are probably of Andean origin. A small version of this loom is also used by the Piro to weave bands and narrow fabrics. The peculiar oval "Ucayali" loom for weaving belts, straps, and the like, is restricted to the Panoan and Arawak tribes.

Like the majority of South American weavings, each fabric is woven to desired size, and lengths of materials are never cut down or tailored to shape. Except among the Jivaro, weavers throughout the Montaña are women.

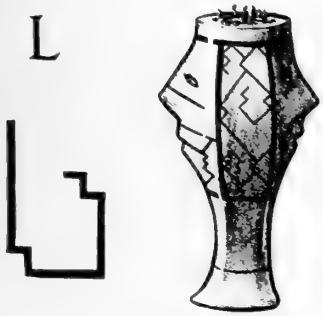
Textiles have both woven-in and painted-on decoration. Elaborately painted fabrics are more typical of the Panoan peoples, while Campa and Piro textiles receive less surface treatment, and tend to run to woven stripes.

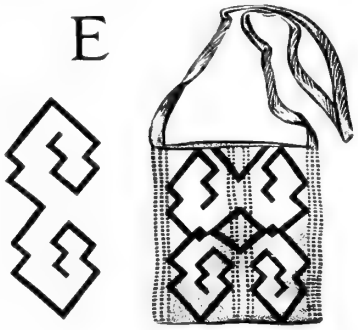
Cotton textile with woven and painted pattern.

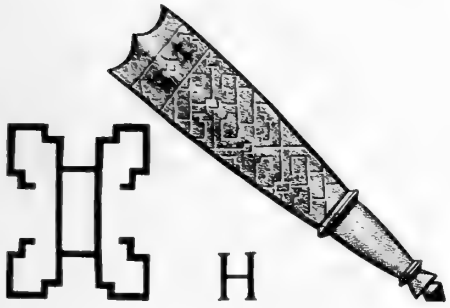
The Panoan tribes are distinguished from other Montaña peoples by their excellent and beautiful painted pottery, the best of which is made by the Shipibo and Conibo. All materials are obtained locally. Fine white clay dug from river banks during the dry season is mixed with charred tree bark and kneaded to a smooth paste. The potter then constructs her vessels by coiling, shaping and thinning the sides with gourd scrapers. No potter's wheel is used. When dry, pots are polished with stones, given a white slip, and painted with geometrical designs. Occassionally small incised lines provide additional decoration.

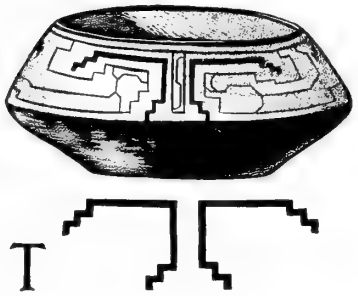
Although a pot is usually baked in an old jar filled with ashes, the large vessels used as beer containers on festive occasions are fired under heaps of dry bamboo. After baking, melted resin is smeared on the outside of the pot with a bone daubing tool, which accounts for the glazed appearance of Montaña ceramics.

Effigy jar representing man with face and body painting. Such vessels were used to store manioc beer.









The Decorative Style

The decorative art of the Montaña tribes is one of the most original and imaginative styles developed by South American Indians. Although it is varied in detail, it is highly unified in feeling, and reaches its fullest expression among the Panoan peoples. Patterns are composed of angular geometric designs, with few curving lines, arranged in such a way that they oppose one another or interlock. In this unique style realism is almost entirely absent. If the geometrical elements were ever symbolic, their meanings have long since been lost. Today the designs are regarded by the Indians as purely decorative.

Typical of the Montaña style are heavy lines paralleled by fine lines of a lighter color or value. The thin lines serve as a framework for the heavier designs, or as a net to draw the bolder masses together into a continuous pattern. As a result, blank areas are few. Basic design units vary in complexity from frets or rectangular spirals to simple elements suggestive of the letters L, E, H, and T.

Ancient pottery from Marajó island.
The triangular object is a pottery tanga, or "fig leaf," once worn by the women.

Where and when the distinctive Montaña art style originated is not known. It seems certain, however, that it is related historically to a decorative style that flourished in the Amazon Basin in pre-Columbian times. On Marajó Island in the Amazon Delta region, archaeologists have excavated ancient effigy jars, bowls, and pottery tangas, or "fig leaves," that resemble Montaña art in many ways. Similar pottery has also been dug from the banks of the Rio Napo in eastern Ecuador.

Whatever its origins, this decorative style has taken a strong hold on the artistic expression of the Montaña peoples. Similar or identical designs are used by them to decorate almost everything they make, regardless of shape, texture, or material.

Social and Political Organization

The social structure of the small and scattered Montaña communities can be described only in the most general terms. Any large political groupings or any sense of tribal unity is lacking, and even the mission villages disintegrated at the close of the mission period in the early nineteenth century, when the Indians resumed their native separatism.

Social structure is equally simple, and classes, castes, or clans are absent. Until trade with the Whites made slavery profitable during Colonial times, captives taken in war were usually incorporated into the local group.

Where the community consists of a single-family house, it is limited merely to the elementary family of father, mother, and children. When several related families live together in a communal household, descent is usually traced through the oldest man, who acts as chief of the family group. The authority of the family head man depends largely upon his wisdom and personality, and he functions mainly in controlling travel, leading war parties, and in supervising the clearing of the family's farm lands. Medicine men occasionally assume leadership, but possess no formal authority over other members of the group.

Spear

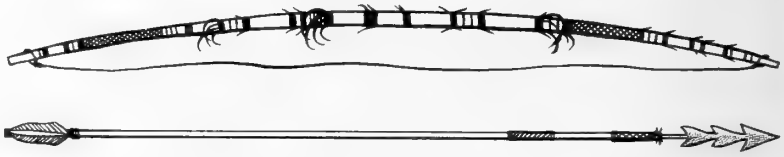
Warfare

Until recently, the Montaña peoples lived in a state of almost continuous warfare. Headhunting was the immediate incentive, although some tribes believed that war promoted abundant crops, luck in hunting, and fertility in women. Others took slaves during raids, principally for sale to Whites. Still other motives included desire for prestige and loot as well as vengeance for sorcery, murder, or trespass on tribal territory.

The main weapons of war were bows and arrows, spears, and clubs, most of which were beautifully decorated, particularly by the Cashibo, with feathers, cordage, human hair, or engraving. War arrows and spears were never poisoned.

Tactics consisted of sudden, stealthy attacks by small bands of warriors, who at-

War club



Bow and arrow

tempted to massacre the men and abduct the women and children. A medicine man, who performed the magic believed necessary to the success of the expedition, accompanied the war party. Because of incessant and sudden raids, the isolated villages were defended by trenches lined with sharpened stakes, and by signal drums hidden in trees.

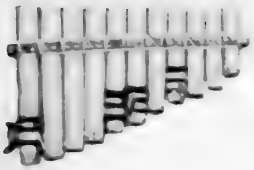
In some remote regions of the Montaña, inter-community warfare is still prevalent. Here, because prowess in war is necessary for the survival of the group, a boy is instructed in the art of warfare from earliest childhood. He is encouraged to play warlike games and is given small, but lethal, weapons. At the age of five or six a Jivaro boy receives daily lectures from his father on the necessity of avenging wrongs done to his family. When he is seven years old he begins to accompany his parent and other warriors on headhunting expeditions. Manhood and full warrior status is achieved when the lad takes his first enemy head.

Headhunting was formerly widespread, but survives today mainly among the Jivaro tribes. The trophy head, or *tsantsa*, is visible proof to the ancestral spirits that a wrong has been avenged. It also gives its possessor great prestige and magical power.

When an enemy is slain, his head is severed with a sharp cane knife and the skin is cut and removed from the skull. The lips are everted and pinned or sewed, and the whole head skin is then boiled with a plant that shrinks it somewhat and sets the hair. It is further reduced by placing hot stones and sand inside. Finally the shrunken head is smoked, polished, and kept in a jar.

When a victim's head cannot be taken, a sloth head, similarly prepared, may be substituted. In recent years the tourist trade has so stimulated headhunting that elaborately decorated trophy heads, adorned with feather crowns and beetle wing ornaments, are prepared especially for sale.

Jivaro trophy head



Pan-pipe

Wooden tobacco pipe with engraved design.

Recreation

In addition to the beerlike beverages made from manioc or other fruits and vegetables fermented with the aid of a chewed mash, the Montaña tribes use several narcotics and stimulants derived from local plants. Smoking is now common, although it formerly was largely restricted to medicine men. Both wild and cultivated tobaccos are smoked in pipes or taken in pulverized form as snuff by means of V-shaped tubes. Large snuff tubes are used by pairs of men, each of whom in turn blows the powder into the other's nostrils.

The practice of chewing coca leaves with lime to reduce fatigue and hunger is limited in the Montaña to the Arawak and some Panoan tribes. Coca, the plant from which cocaine is derived, is native to this region. Other narcotics are used by medicine men for magical or medical purposes.

Music is not highly developed in the Montaña, and musical instruments are played mainly to accompany the dances occasioned by drinking bouts. Although they are now in general use in the region, two-headed drums are probably of Spanish origin, as may be the musical bow. Native instruments include pan-pipes, flutes, whistles, trumpets and ocarinas.

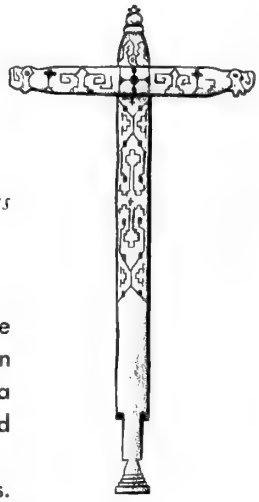
Unlike many primitive tribes, the Montaña peoples spend considerable time and

Musical instruments.

thought making special toys for their children. Infants amuse themselves with a variety of rattles manufactured of plaited palm leaves, gourds, or stones. Tops and balls are also common childhood playthings for older children. As soon as they are able, however, boys are encouraged to learn adult activities by playing with blowguns, canoes, and the like. Similarly, dolls and miniature household utensils teach little girls their future duties as adult women. Adult games consist of wrestling matches and games with maize-leaf balls.

Manatee breast bone

Girl painted for puberty rite



Ceremonial cross

Ceremonial and Religious Life

Today Christianity has been so widely adopted that it has largely replaced native religion in all but the most inaccessible regions of the Montaña. Indeed, little is known of the traditional beliefs of the area save that, owing to their isolation, the Montaña peoples lacked the more complex ceremonial life typical of both the Andean and Amazonian culture centers.

The most important ceremony of the Panoan tribes is that held for adolescent girls. During a feast that lasts for as many as ten days, the girls are painted, stupefied with drink, and circumcised by the older women.

Most Montaña peoples believe in the existence of spirits who are thought to inhabit various natural objects, including stones, animals, and even plants. Other prominent supernatural beings consist of a monstrous water snake, and a variety of bush demons, conceived either as pygmies or as animal spirits.

Among several tribes, hunting ritual plays an important role. According to legend the first Conibo to kill a manatee cut out the breast bone of the animal and threw it into the sky, where it became the Southern Cross. Thus the cross, which here has nothing to do with Christianity, has become a symbol sacred to manatee hunters.

The principal function of the medicine man is to cure sickness and to send disease to enemies of the group. He also performs war magic, controls the weather, and predicts the future. Often he has a spirit helper in the form of a bird, animal, or snake, or else derives his power from tobacco, which he also uses to cure disease.

Sickness is conceived as a dart or thorn which the medicine man may shoot into his victim or remove from his patient by magical means. There is also the widespread belief that the medicine man controls jaguars, snakes, and other dangerous animals, and that he may summon these to attack his enemy.

Beliefs about life after death are varied and confused, but most tribes maintain that the soul is reincarnated as an animal, often a deer. Others believe that the soul merely wanders forever throughout the rain forest of the Montaña.

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INDIANS

OF NORTH AMERICA

BY HARRY TSCHOPIK, JR.

INDIANS OF NORTH AMERICA

The cover designs have been taken from a painted Cheyenne elk hide robe of the late nineteenth century. The halibut motif on the title page is from a small mat woven of spruce root by the Haida Indians of the Queen Charlotte Islands.

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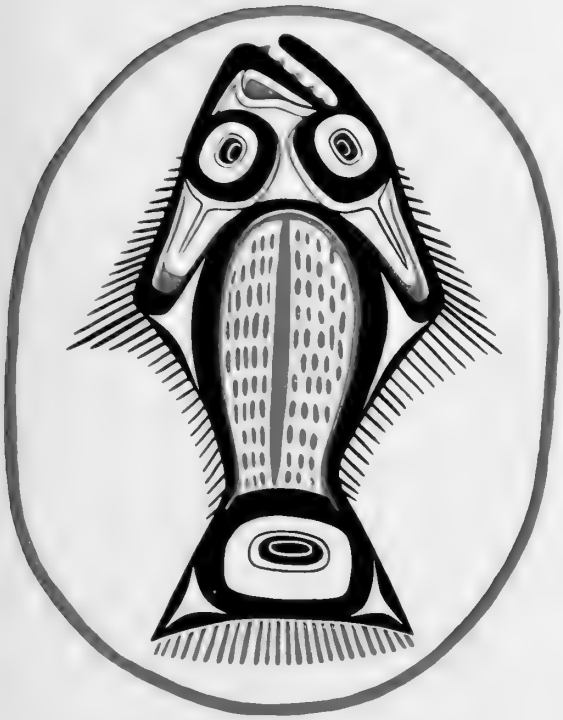

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1952

Painted buckskin shield cover showing battle between White soldiers and Indian warrior. Sioux.

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The earliest Indians hunted species of animals now extinct on the North American continent.

The ancestral American Indians, of course, did not all arrive at once. It is probable that there were repeated migrations of small bands of people over long periods of time. Once in the New World, however, several routes were open to the newcomers. Even during the height of the glaciations, geologists tell us, the interior of Alaska was free of ice, and the Mackenzie Valley cleared early. Down this broad valley the first Indians wandered, spreading out into the plains, eastward into the Mississippi Valley, and westward to the foothills of the Rocky Mountains. Others traveled southward along the Pacific Coast, to the west of the Sierra Nevada Mountains. Gradually the early immigrants penetrated Mexico and Central America, eventually populating the South American continent. These wanderings and migrations may have taken place over a period of as much as ten thousand years, and they go far to explain the racial, linguistic, and cultural diversity of the American Indians.

THE NORTH AMERICAN INDIAN RACE

Although there are still important gaps in our information, sufficient evidence is at hand to indicate that, like other broad divisions of mankind, American Indians taken as a group exhibit considerable range and variety of physical features. There are, in fact, few physical characteristics that are typical of all Amerian Indians, and these are limited to such general features as dark brown eyes, coarse, black hair that is straight or slightly wavy in form, and to a broad, rather heavy face. Skin color varies from yellow-brown to red-brown, but is never truly red. The origin of the term "red-skin" is uncertain, but it may refer to the widespread North American Indian practice of painting the skin with red paint.

In other respects, such as stature, head form, nose form, face length, and the like, American Indians exhibit great variety, probably equal to that of the White race taken as a whole. From the racial point of view, therefore, there is no such thing as a "typical" American Indian. There are several distinctive local types, as well as blends of these.

The Indian who formerly inhabited much of the eastern United States was tall, spare, and long-headed, with a high, hawk-like nose, broad face, and a massive chin that jutted below a thin-lipped mouth. This type survives in the Plains, and is represented on the buffalo nickel. In contrast, the present Pueblo dwellers of the Southwest are short, squat, and thickset people with broad heads, smaller and finer features, and noses that are straight or even concave in profile. Finally the very short, stocky Eskimo, with their narrow skulls, broad, square faces, yellowish skin, and Mongoloid eyes, represent yet another highly distinctive native American sub-group. Still other physical types exist or existed on the Northwest Coast, in Mexico, and in tropical America.

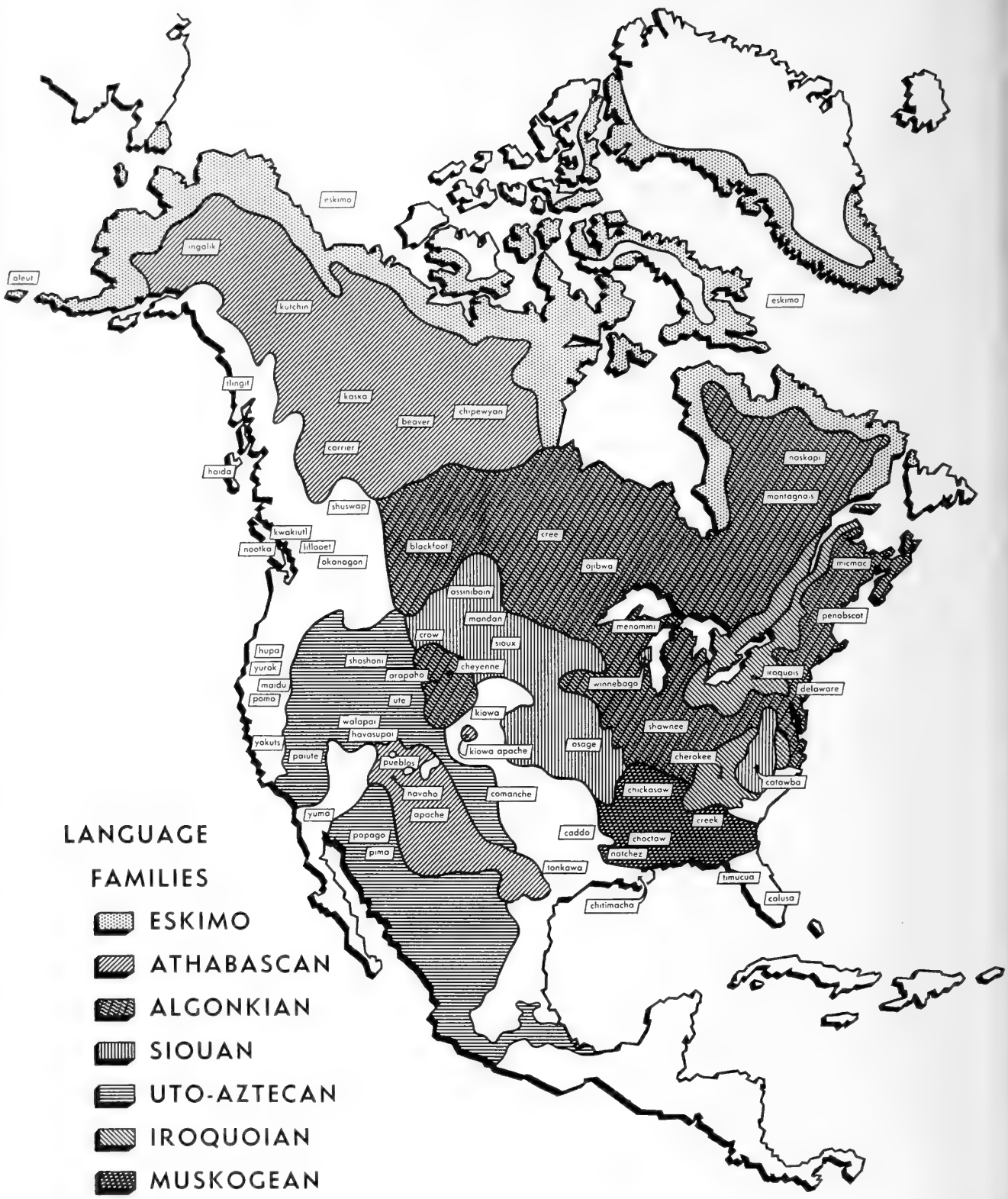
Several factors are responsible for the physical variability of the American Indian. Much local differentiation and specialization undoubtedly took place after the ancestral American Indians arrived in the New World. It likewise seems certain that the physical variation apparent in American Indians is in part a result of the perpetuation of existing varieties among the various groups of immigrants. In other words, the countless small bands of people who entered the New World over a period of thousands of years did not all have identical ancestry, a theory that is all the more reasonable when one remembers that there is considerable variability among the Mongoloids themselves.

There is always the possibility that some islanders of the South Pacific may have reached America in canoes, but most authorities feel that these could not have arrived in numbers sufficient to affect the physical characteristics of the American Indian population. The American Indians, then, probably represent the descendants of several types of Asiatics who became even more specialized and differentiated after they had settled upon American soil.

Cheyenne warrior of the Plains.

Hopi farmer of the Southwest.

Eskimo hunter of the Arctic Coast.



TRIBES AND LANGUAGE FAMILIES OF NORTH AMERICA

NORTH AMERICAN INDIAN LANGUAGES

In the Western Hemisphere one finds greater linguistic diversity than in any other area of the globe. At the time of the discovery of the New World, languages belonging to some 55 language families were spoken in North America alone. Most of these families seem to have been entirely distinct and unrelated to one another, and even the component languages embraced within them were not mutually intelligible. Considering North American Indian languages as a group, there appear to be no structural or phonetic features peculiar to all or even most of them, or any distinctive characteristics that set them off from other linguistic areas of the world. Nor has any American Indian language ever been shown to be related to any language of the Old World. It seems most likely, however, that as studies of American Indian languages progress, the number of distinct or isolated families will be reduced, and that some of them, at least, will be shown to be related to Old World language families.

The historical picture is further complicated by the fact that there is virtually no correlation in aboriginal North America between language and culture. Thus the Cheyenne and Crow tribes of the western plains shared a common culture, but spoke totally unrelated languages. Conversely, the Hopi farmers of the Southwest and the Paiute hunters and gatherers of the Great Basin spoke closely related languages, but possessed vastly different cultures. In spite of the complexity of the linguistic situation in North America, however, language has often proved a useful tool in tracing the movements and histories of the various Indian tribes. Even if we lacked historical proof, for example, it could be demonstrated on linguistic grounds that the Algonkian-speaking Arapaho moved into the Plains area from Central Canada or the Great Lakes region, the center of distribution of the Algonkian language family. Similarly, even though historical evidence is lacking, it is certain that the Athabascan-speaking Navaho and Apache migrated southward into the Southwest from the original Athabascan homeland in northwestern Canada.

It goes without saying that North American Indian linguistic stocks varied considerably with respect to the number of speakers. Some, like Algonkian and Uto-Aztecan, stretched through tribe after tribe, across enormous areas of the continent while others, like the Yanan stock of northern California, were spoken by only a few hundred people. At the present time a large number of languages spoken at the time of the discovery are entirely extinct, or are spoken by remnants of once important tribes. A far fewer number, like Navaho and some of the Uto-Aztecan languages, continue to be spoken by large numbers of Indians.

The first comprehensive classification of North American Indian languages was made by Major J. W. Powell in 1891 and, with minor modifications, this classification is still in general use. The most important of Powell's linguistic stocks to the north of the Mexican border are as follows:

1. *Eskimo:* spoken along the Arctic coast from the Aleutian Islands to Labrador, as well as along the coast of southern Greenland, and the easternmost tip of Siberia.
2. *Athabascan:* spoken in northwestern Canada, the Southwest, and by isolated groups on the Pacific coast.

3. *Algonkian:* spoken from Labrador and the north Atlantic coast to Montana, as well as in the Mississippi Valley into Virginia.

4. *Iroquoian:* spoken from Lake Erie to the Gulf of St. Lawrence, and also by isolated tribes in the Carolinas and Virginia.

5. *Muskogean:* spoken in the southeastern United States, for the most part to the east of the Mississippi River.

6. *Siouan:* spoken in the mid-western and eastern United States, principally west of the Mississippi from Saskatchewan to Arkansas, but also by isolated tribes in the Carolinas and Virginia.

7. *Uto-Aztecan:* spoken widely from the Great Basin southward into Mexico and Central America.

These seven language families occupied the greater portion of the North American continent. A far larger number of languages, however, was concentrated in a narrow band along the Pacific coast, especially in the area between northern British Columbia and southern California, where the linguistic situation was extraordinarily complex. The area lying between the central plains and the Gulf of Mexico was inhabited by speakers of the Caddoan language, as well as by the linguistically isolated Kiowa, Tonkawa, and other small groups. In the southeastern United States, Yuchi of Alabama and Georgia, Tunica, Atakapa, and Chitimacha in western Louisiana, and Timiquan and Calusa in Florida, represent other isolated languages.

Linguistic diversity in North America probably reflects, like race, an original diversity among the ancestral Indians who immigrated into the New World. It seems not unlikely that the languages spoken by the small, isolated tribes of California and the Intermountain zone may represent the speech of the earlier immigrants. In all likelihood these tribal groups were subsequently pushed into these marginal areas by successive waves of later migrants who spoke Algonkian, Siouan, Athabascan, and other languages that at the time of the discovery of America had attained wide distribution.

NORTH AMERICAN INDIAN CULTURE

At the time of the discovery of the New World, it has been estimated that approximately a million Indians inhabited America north of Mexico. This population was not, of course, distributed evenly over the northern continent, but instead, as stated earlier, was divided into some 300 tribal groups that differed markedly in size. Some, like the Paiute of Nevada, consisted merely of one or more small bands of primitive hunters and gatherers who roamed about in search of seeds and nuts, game and fish; in many respects their way of life was scarcely more advanced than that of the Old Stone Age. Other groups numbered several thousand souls who, like the Pueblo tribes, lived in large permanent towns, carefully constructed of stone masonry. These peoples were advanced agriculturists and master craftsmen, possessing a rich religious life and a complex socio-ceremonial organization. Between these two extremes one notes an endless gradation in group size, and a bewildering variety of cultural expression.

Indeed there are remarkedly few common denominators of North American Indian cultures taken as a whole, and these are of so generalized a nature that they are equally characteristic of the primitive peoples of the Old World as well. Such a list would include the following:

Knowledge of the bow and arrow
Knowledge of traps and weirs
Knowledge of string and cordage
Knowledge of skin dressing
Use of chipped stone tools
Use of ground bone and stone tools
Use of fire for warmth and cooking
Some form of shelter
Domesticated dogs
Baskets and mats
Folktales and mythology
Songs
Dance forms
Belief in spirits
Practice of magic
The family group

This simple, generalized cultural inventory—the few items that can be cited as typical of North American Indians as a whole—also represents the cultural equipment of the earliest immigrants to the New World, although it is likely that the spear and spear-thrower preceded by some thousands of years the use of the bow and arrow. In all probability the earliest Indians also possessed shamans, or medicine men, puberty ceremonials for girls, initiation rites for boys, and celebrated some form of funeral observances. Our knowledge of this ancient American cultural stratum is not based solely upon archaeological evidence since, in such isolated areas as California and the Great Basin, primitive cultures of this type survived well into historical times.

A description of the growth and development of the native cultures of North America is beyond the scope of the present article, but the bare outlines may be suggested. Once in the New World, the earliest immigrants with their meager cultural equipment drifted about until they found localities that suited their needs, and then settled down to life in their new environment. Gradually each group adapted its tools and skills to the problems posed by its new mode of existence, and slowly became differentiated from other groups.

As time passed, new waves of immigrants brought over new inventions and discoveries from Asia—snowshoes, tailored skin clothing, basketry hats, moccasins, and cord-marked pottery—and these spread over the northern portions of the continent. Far to the south, in the area between Mexico and Peru, native American culture forged rapidly ahead, and the basis was laid for a brilliant high civilization that was to have widespread influences throughout the New World.

From Mexico, agriculture, weaving, ceramics, and many elements of ceremonial practice spread gradually into the Southwest, while these and other features of Mexican culture, such as pyramids, temples, human sacrifice, and the like, eventually reached the southeastern United States. In both areas, the Mexican influences were merged and combined with the existing older culture elements, and were modified in accordance with local conditions.

CULTURE AREAS OF NORTH AMERICA

The Northwest Coast tribes, situated as they were at the very gateway to the New World, received strong and specific cultural stimuli from the Asiatic continent, and these influences are apparent in their art style, their Chinese-type armour, and their plank houses. To some primitive tribes, on the other hand, isolated behind the mountain barriers of California and the Great Basin, cultural elements from Asia and Mexico never penetrated. As a consequence they remained, until recently, culturally retarded relics of another age.

Thus, at the time of first White contact, North American Indians exhibited great cultural diversity. In order to cope with this seemingly endless variety of cultural expression, and to organize the data on North American Indians into some kind of order, anthropologists developed the concept of "culture areas." Briefly, a culture area may be defined as a group of geographically contiguous tribes possessing so many elements of culture in common that they contrast significantly with other such groups.

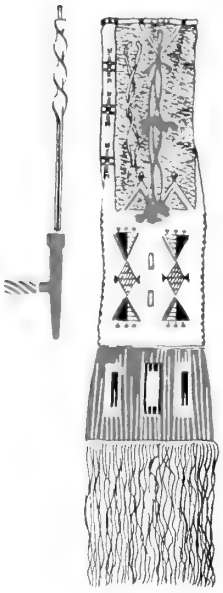
Although the tribes of a given culture area share a similar culture, they are by no means identical. What gives a culture area its distinctiveness are the tribes at its center; those along the margins almost always exhibit some culture elements more characteristic of adjacent areas. Thus in the Plains area, the centrally located Arapaho and Sioux are considered most "typical," while the Ute on the western fringe of the Plains show relationships with the Great Basin and the Southwest.

There is a close and intimate correlation between culture area and environment. On the one hand, cultures tend to conform to areas of environmental uniformity; on the other, environment tends to stabilize culture and to hold it fast. For example, the distribution of Northwest Coast culture, dependent upon salmon fishing and cedar forests, coincided with the foggy, wet, coniferous forests of British Columbia and southern Alaska. Similarly, Plains culture, based upon buffalo hunting, was confined—in historical times, at least—to the vast, barren grasslands of the midwest and western United States, the traditional range of the buffalo.

What is really most distinctive about a culture area, then, is its economic and technological adaptation to a particular ecological area. For this reason anthropologists have relied most heavily upon subsistence patterns and material traits in assigning tribes to a given culture area.

For present purposes the Indian tribes of North America to the north of the Mexican border may be classed in the following culture areas:

1. Plains
2. Southwest
3. California-Intermountain
4. Northwest Coast
5. Eastern-Northern
6. Arctic Coast



PLAINS

It is a curious fact that Plains culture, the best known of all the North American Indian cultures to the general public, was the latest of all of them to develop. Indeed, Plains culture as we know it did not come into being until well after the discovery of the New World; not, in fact, until the Plains tribes had acquired horses escaped from Spanish exploration parties of the seventeenth century in the west.

Historical Plains culture coincided, for the most part, with the open, treeless prairies of the central and western United States, a vast tract of rolling grassland that supported countless thousands of buffalo, or bison. In prehistoric times, however, the plains were sparsely inhabited. Before the acquisition of the horse gave them almost unlimited mobility to follow the buffalo herds, most Plains Indians lived about the fringes of this area, or farmed the bottoms of the river valleys, as did some Siouan and Caddoan tribes during the historic period. These sedentary peoples, represented in the nineteenth century by the Mandan and their neighbors, lived in palisaded villages of earth lodges, cultivated maize, beans, and squash, and manufactured basketry and pottery. To the village-dwelling Plains tribes, bison hunting was a secondary and seasonal activity, since without horses there was no effective way to exploit the buffalo herds. Once mounted on horseback, however, many tribes abandoned agriculture altogether, and gradually streamed out into the open plains to become nomadic hunters.

The new and exciting way of life attracted tribes belonging to most of the great linguistic families of North America: the Algonkian-speaking Blackfoot, Cheyenne, and Arapaho; the Siouan-speaking Crow, Assiniboin, and the Sioux proper; the Uto-Aztecan Shoshoni and Ute; and the Athabascan Kiowa Apache. Regardless of what their original culture had been, they shed it for the life of the Plains.

The teeming herds afforded them seemingly inexhaustible riches, with the result that Plains culture emerged in a sudden burst of barbaric splendor that lasted until the west was opened to White settlement about 1850. As suddenly as this colorful way of life arose, however, it vanished before the hordes of pioneers pushing westward. By 1880 the buffalo was all but exterminated, and Plains culture, except in memory, had become extinct.

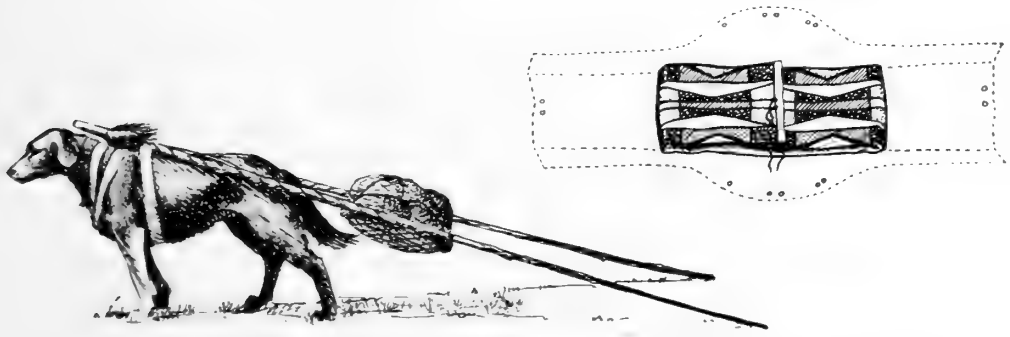
Above: stone pipe and beaded pipe bag. Sioux.

Plains culture and the bison are inseparable. Dependence upon the herds made farming impractical, and little use was made of fish. Although wild roots and berries as well as agricultural products obtained by trade were eaten when available, and although elk, antelope, and other game animals were also hunted, the buffalo was the staff of life and the chief source of raw materials. Its flesh fed them, its hide clothed them and furnished material for their houses. Buffalo bones and horn were used for tools and utensils, and dried buffalo dung supplied fuel. Social life and daily routine revolved around the lumbering herds.

Buffalo were usually hunted by parties of mounted men who either surrounded the animals and dispatched them with arrows and spears, or drove the herd over a cliff or into a corral where the bison could be shot at will. Surplus meat was dried, or pounded with a stone maul to prepare *pemmican*. This pulverized meat, mixed with melted fat and occasionally with mashed berries, was stored in rawhide envelopes, or *parfleches*, where, with proper care, it would keep for years. Because pots and baskets were scarce or absent, food was boiled in a fresh skin placed in a hole in the ground, the water being heated with hot stones. Other utensils and tools consisted of horn spoons, bone awls, and scrapers for dressing skins, and a great variety of skin bags.

Since it was necessary to move camp to follow the buffalo herds, most Plains tribes abandoned their former earth-covered lodges in favor of conical, skin-covered tents, or *tipis*. These portable houses, assembled and dismantled by the women, were dragged from place to place by horses or dogs on V-shaped frames of poles, known as *travois*. When all the members of one or more bands camped together, the *tipis* were erected in a great circle, often with a council *tipi* in the center.

Weaving was entirely lacking in the Plains, and clothing, therefore, was made of soft tanned skins. Men usually wore a breech clout and moccasins, as well as leggings and shirts on festive occasions, while women wore moccasins, short leggings, and sleeveless, one-piece dresses. Both sexes used buffalo robes in cold weather. Extensive use was made of feathers, especially those of the eagle, to adorn headdresses, lances and shields. Plains Indian clothing, bags, cradles, and other objects were usually decorated with elaborate geometric patterns of porcupine quillwork or, more recently, of glass beads obtained from White traders. Most of these motifs, although named, were purely decorative, and lacked any deep, symbolic meaning. Shields, buffalo robes, and *tipi* covers, on the other hand, often had painted designs, some of a lively, realistic character, that were intended to make known the exploits of the owner.



Left: Travois; right: Parfleche drawn open and closed.

Blackfoot encampment, about 1908.

Plains Indian society was organized along simple lines. With the exception of the Crow and the village-dwelling tribes of the mid-west, clans were lacking, as were class distinctions. Chieftainship was of an informal nature, and the families of the same area were merely grouped into loosely organized bands.

Most tribes possessed a series of societies or fraternities for men, often ranked according to age in such a way that as a man grew older he passed successively from one to the next. Each society had its officers, songs, and special regalia. Some were of a military nature, others had ceremonial functions, and still others policed the camp, supervised the buffalo hunt, and acted as scouts both for hunting and in warfare.

Next to bison hunting, warfare was the chief interest of Plains Indians. According to our concepts, Plains warfare more nearly resembled a game, although a dangerous one. Most skirmishes were conducted on a small scale, rarely involving an entire tribe, or even a whole band. Ambush and surprise attack were characteristic features, while deliberate wars of conquest or extermination were almost unheard of. War parties could be organized by any warrior eager for glory or loot, and the stealing of horses from enemy tribes was a prominent motive. The doing of great and nobles deeds was the sure avenue to prestige in Plains society, and the Sioux, Cheyenne, and other tribes had a definite system of graded war honors called "coups," the highest ranking of which consisted merely of touching an enemy during combat. Returning warriors boasted of their heroic deeds in battle, and celebrated victory with a scalp dance.

The religion of the Plains Indians was highly personal and individualistic. True gods were lacking; instead the Indians believed in a kind of impersonal supernatural power that could, under proper circumstances, be imparted to man. Such power was necessary to the success of all important undertakings, and so was sought by nearly all adult men, and by some women. The person seeking power went to a lonely spot where he fasted and prayed until he received a dream or vision. In this vision he met a spiritual

guardian, usually an animal or bird, who taught him a song and gave him a shell, skin, feather, or other token to keep as a charm. Since nearly all males had some supernatural power, a shaman was simply a man who had greater power and more potent "medicines."

In addition to these personal "medicines," there were larger and more important bundles of ritual objects that were owned by the tribe as a whole, and that were never opened save on ceremonial occasions. The sacred articles contained in the tribal medicine bundles consisted of such things as animal and bird skins, pipes, dried herbs, rattles, tobacco, paint, and even ears of corn. In effect Plains ceremonies were demonstrations of the ritual associated with the medicine bundles, and of the visions during which they were thought to have originated. Yet masks were not used nor were deities impersonated as in other parts of aboriginal North America.

Most Plains tribes had ceremonies connected with buffalo hunting which were designed to control the bison and make them available. The most widespread and important Plains ceremony, however, was the Sun Dance, which was performed annually and was usually sponsored by an individual in fulfillment of a vow made in time of great danger. For this ceremonial a special round structure was built around a central "Sun Pole" and altar. During the ceremony the painted warriors, who had previously spent several days in fasting and purification, took turns dancing while gazing steadily at the sun, praying and singing for guidance, and occasionally torturing themselves.

Plains culture, therefore, was nomadic, warlike, and individualistic, and was based almost exclusively on hunting. In all these respects the Plains Indians contrasted sharply with the Pueblo dwellers of the Southwest.

Mandan buffalo dance. Maximilian, 1843.

SOUTHWEST

The term "Southwest" designates a vast area lying to the south of the more clearly defined Rocky Mountain ranges between the Colorado River on the west and the Rio Grande-Pecos drainage system to the east. In large part this region lies within the present states of Arizona and New Mexico. The northern portion is a high, semi-arid plateau, sculptured by wind and water into towering buttes and mesas, steep-walled canyons, and dry, sandy washes. Vegetation consists mainly of piñon and juniper, with forests of pine and fir in the higher mountains. To the south of the Colorado Plateau, elevation decreases abruptly and the mountains give way to the flat, arid desert country of the Gila and Salt rivers. Here the sun-baked terrain is covered by mesquite, creosote bush, and by a great variety of cacti.

Although as a matter of convenience anthropologists have long considered the Southwest as a "culture area," the region is conspicuously lacking in cultural unity. When the first Spanish explorers entered these desert wastes in 1539, they encountered native peoples who ranged in cultural complexity from the primitive Walapai hunters and gatherers on the one hand to the sophisticated town-dwelling Pueblos on the other. Bands of warlike, semi-nomadic Apache and Navaho ranged the cliffs and canyons, while the deserts southward to the Colorado were inhabited by such primitive farming tribes as the Papago, Pima, and Yuma.

Language likewise reveals an essential lack of unity. The Navaho and Apache speak Athabascan dialects; Yuma, Walapai, and Havasupai belong to the Yuman stock; while Pima, Papago, and the speech of the Pueblo-dwelling Hopi are Uto-Aztecan languages. In regard to other Pueblo groups, the Rio Grande peoples speak Tanoan or Keresan dialects, the western Pueblo of Acoma is likewise Keresan, and the speech of the Zuñi is distinct and independent of all others.

On cultural grounds it is possible to classify the Indians of the Southwest into three major groups: 1, the Pueblos; 2, the Southern Athabascans; and 3, Ranchería tribes.

Above: painted wooden figurine representing a *kachina*, or supernatural being. Hopi.

THE PUEBLOS

It is the colorful and spectacular culture of the town-dwelling Pueblo Indians that gives the Southwest area its distinctive characteristics. The Pueblo peoples and their ancestors and predecessors have inhabited the Colorado Plateau at least since the beginning of the Christian era, and the broad outlines of the growth and development of their culture are well known to archaeologists. At the time of their greatest geographical expansion in the tenth century A.D., Pueblo villages were scattered across the Southwest from the plains of Texas to the desert wastes of Nevada. Subsequently, however, owing to drought, to raids by the warlike Navaho and Apache, and to other factors, Pueblo towns were condensed into fewer, but larger, communities.

When the Spaniards under the leadership of Francisco Vásquez de Coronado first met them in 1540, the Pueblo peoples occupied approximately the same territory—and even some of the same villages—as today. Although many American Indian cultures have disappeared entirely before the impact of modern civilization, Pueblo culture has proved remarkably resistant to change. In spite of four centuries of intensive contact with Whites, the conservative Pueblo peoples cling to their traditional way of life with incredible tenacity, and continue in many ways to live as they did at the time of the discovery of the New World.

Taos Pueblo in the upper Rio Grande drainage.

Although important cultural differences exist between the eastern, or Rio Grande, villages and the western Pueblos of Acoma, Zuñi, and Hopi, the basis of life is everywhere intensive agriculture. Despite the semi-arid environment, where seasonal rains may make all the difference between abundance or starvation, the Pueblo farmers cultivate their fields of corn, beans, squash, gourds, tobacco, and cotton, and also grow melons, peaches, and garden vegetables of Spanish introduction. Essential to Pueblo agriculture is the utilization of naturally flooded areas along the rivers and washes since irrigation is not widely practiced. Even today few Indians own plows, preferring the simple, but efficient, wooden digging sticks, weed-cutters, and hoes of pre-Columbian times. The great bulk of agricultural labor is performed by men, with the assistance of the women during planting and harvesting. In many villages religious officials known as Sun Watchers observe the solstices and equinoxes and announce the proper dates for the various activities connected with farming, for Pueblo agriculture is intimately linked with Pueblo religion. Of the above-mentioned crops, corn is not merely the staff of life; it is a sacred substance of central importance in Pueblo ceremonialism, an object of worship, and an ingredient of most offerings to the gods.

In addition to farming, the Pueblos formerly did some hunting, and also traded corn with neighboring tribes for game and hides. People of the Rio Grande villages journeyed regularly to the plains to hunt buffalo, while those of the western villages confined their hunting to antelope, elk, deer, and, above all, rabbits. The latter were taken in large numbers during communal drives, and were killed with arrows or boomerang-like throwing clubs. The fruits of yucca and cacti, as well as berries and piñon nuts were formerly gathered by the women, but played no important part in Pueblo diet except in times of famine. Although the turkey and the dog were the only domesticated animals kept in pre-Columbian times, the Indians today raise some sheep and other livestock introduced by the White man. The entire framework of Pueblo life, however—economic and religious—centers around agriculture, rain-making, and crop fertility.

In former times many Pueblo towns were built on high, steep-sided mesas for purposes of defense. Most present-day villages, whether located on mesa tops or in canyon bottoms, preserve numerous features of ancient town planning. Each consists of community houses constructed of stone and adobe, and arranged around one or more plazas. Some buildings are of several stories, the uppermost of which is terraced back from the one below so that the roof of the lower house provides a kind of gallery, or balcony, for the house above. Access to the upper apartments is furnished by means of ladders. Situated in the plaza of the town are one or more special ceremonial structures, usually partly underground, called *kivas*. In addition to serving as chapels where religious rites are performed, these buildings are used as clubhouses and workshops by the men.

The peaceful Pueblo Indians are expert craftsmen, early attaining great technical proficiency in the arts. The women of most villages produce excellent pottery, handsomely decorated with painted designs. Although some patterns represent conventionalized deer, birds, flowers, and the like, most designs are curvilinear and geometrical. Weaving, on the other hand, is a masculine pursuit, and the few textiles produced at the

Pueblo pottery. Left, Acoma; center, Hopi; right, Santo Domingo.

present time are woven of both cotton and wool. Recently, however, Pueblo weaving has begun to decline owing to the great numbers of superior fabrics woven by the Navaho, and the availability of commercially manufactured goods. Basketry was formerly made at all villages, but is confined today to the Hopi towns, where excellent coiled and wicker-work trays are produced. The art of silversmithing was borrowed from the Mexicans at an early date, but reached a higher development among the Navaho, who trade their products in the Pueblo villages. In addition to the above-mentioned crafts, most Pueblo men spend considerable time and effort in the preparation of masks, headdresses, altar pieces, and other ritual equipment for the numerous and elaborate ceremonials.

Traditional Pueblo dress styles are fast disappearing, with the exception of the costumes worn during ritual dances. Men formerly wore a loin cloth, a poncho-like shirt, and a kilt, all of native-woven cotton cloth. Leather leggings and rabbit skin blankets were used during cold weather, and buckskin moccasins or fiber sandals when traveling. Some women still wear the traditional dress consisting of a long wool garment fastened over the right shoulder and under the left arm. Moccasins, wrap-around buckskin leggings, and woven shawls complete the woman's costume. Both sexes wear a great variety of ornaments, including earrings and necklaces of shell and turquoise, and, at the present time, of silver as well.

It is in respect to social and ceremonial life that the division between the eastern and western Pueblos is most marked, with the most complex expression of Pueblo culture found at Zuñi and the Hopi villages. Throughout the area, however, individual behavior and achievement is subordinated to group activity, since the peace-loving Pueblos place heavy stress upon community solidarity. A town is governed by a council and a village chief, although usually there is a war chief as well who formerly functioned primarily in defensive warfare.

The most important unit of social organization in the west is the clan which traces descent in the female line. Here women own the house, the furnishings and the food stores, and at marriage a man takes up residence at the house of his wife's parents. Among the eastern Pueblos, clans are unimportant or lacking, being replaced by the simple family unit with the father at its head.

The most distinctive feature of Pueblo culture, perhaps, is its complex ceremonial organization and the degree to which ritual and mythology have been elaborated. Religion pervades Pueblo life to such an extent that authorities have estimated that Pueblo men spend at least half their time engaged in religious activities. Most of these rites are performed to bring rain and abundant crops, and nearly all of them involve such agricultural or meteorological symbols as growing plants, rainbows, cloud terraces, and the like.

Especially typical of the western Pueblos is an elaborate ceremonial calendar in which dances and rites are arranged in an annual cycle. The more important of these are performed by dance societies, or *kiva* groups, each headed by one or more priests who officiate and supervise the religious activities. A ceremony begins with secret rites in the *kiva,* where the members of the society, under the direction of the priests, fast, purify themselves, and prepare the altars, fetishes, offerings, and above all prayer sticks, which are thought to convey the prayers to the gods. This is usually followed by a public performance in the town plaza by groups of masked dancers who impersonate the appropriate deities.

The principal Pueblo deities are the sun and the earth-mother. Others include wind, cloud, and thunder spirits, as well as supernatural beings associated with other natural phenomena, and with animals. Ceremonial life centers chiefly, however, around the *kachinas,* the spirits of departed ancestors, who are most friendly toward mankind and are most frequently impersonated in the masked dances. These spirit-beings control weather, and return to the villages, when properly summoned by ceremonies, to bring rain to the fields of their needy descendants.

The religious life of the eastern Pueblos is generally similar, although less complex. Most characteristic of these villages is a dual division of each town for ceremonial purposes, and the emphasis placed upon curing societies and animal dances. Spanish influences are most marked in this area, and some Pueblos of the Rio Grande region have in addition borrowed such features from the neighboring tribes of the Plains as songs, details of costume, and ritual dances.

Masked dance at a Hopi village.

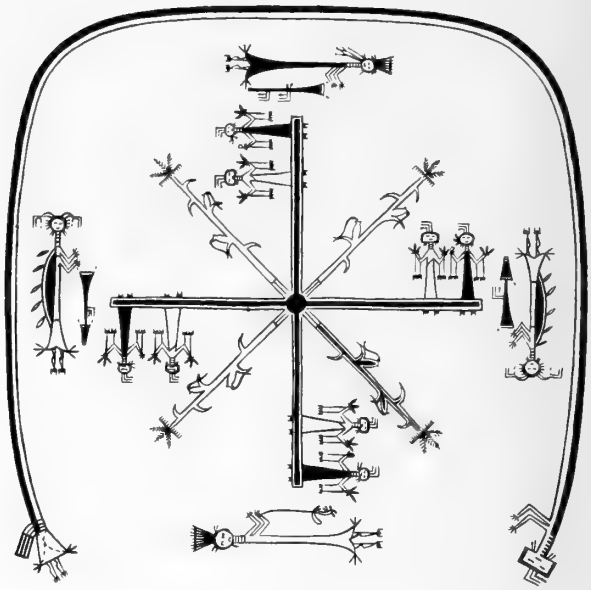
Navaho encampment showing the circular log dwelling for winter use and the brush shelter for summer. About 1908.

THE SOUTHERN ATHABASCANS

It is not known when the Southern Athabascans first entered the Southwest after migrating southward from their ancestral home in northwestern Canada. At any rate they were firmly entrenched in their new environment when the first Spanish explorers encountered them in the sixteenth century. The Western Apache settled the headwaters of the Gila and Salt rivers, while other bands spread over southern Arizona and New Mexico, eastward into the Plains, and southward into the north Mexican desert. Although the several Apache tribes differed from one another in many details, the Western Apache may be taken as representative. The Navaho elected to dwell around and between the Pueblos, whom they attacked whenever the opportunity presented itself, and from whom, nevertheless, they borrowed many elements of culture.

In spite of more marked Pueblo influence in Navaho culture, these peoples and the Western Apache shared a way of life that was basically similar. Both, although they adopted agriculture from the Pueblo farmers, depended in former times to a considerable extent upon hunting deer, antelope, rabbits, and other small game, and upon the gathering of cactus fruit and roots, piñon nuts, and other wild foods. Both led a roving, semi-nomadic existence, conducting savage raids against Mexican and Indian settlements alike for livestock and booty.

The Western Apache and the Navaho are today organized into matrilineal clans, and dwell in widely scattered family encampments rather than in fixed villages. The former live in dome-shaped brush huts, while the latter build log houses, roughly circular in plan, with earth-covered roofs. Both possess rites for adolescent girls, and together share a religion that tends to personify animals, plants, and the forces of nature. Basic ceremonialism is extremely similar, and the mythologies of both groups deal in large part with the deeds of a heroic legendary hero, Slayer of Monsters.



Sand paintings are made by the Navaho for all curing ceremonials. This one, representing Holy People and corn plants, surrounded by the rainbow, is from the Night Chant.

Owing to the intensive contacts of the Navaho with their Pueblo neighbors, the former tribe is distinguished from the Western Apache in a number of respects. The Navaho early adopted Pueblo dress, loom weaving and painted pottery. To the town-dwellers also the Navaho owe much of their complex ceremonialism, including such features as sandpaintings, prayer sticks, offerings, and masked dances. These ritual elements, however, they modified in terms of their dominant cultural interest—the curing of disease. During a later period the Navaho borrowed sheep herding, horse breeding, and silversmithing from the Spaniards and Mexicans, as well as details of the White man's costume. Today the Navaho are renowned as weavers of woolen blankets and produce the finest silverwork in the Southwest.

Lacking such intensive Pueblo contacts, the Western Apache way of life appears impoverished in contrast to the Navaho. In basketry alone do the Apache excell their more advanced kinsmen. Although curing rites are important, the rite held for adolescent girls has become the focus of tribal interest and the most spectacular public ceremonial of the Apache Indians.

THE RANCHERIA TRIBES

The third major cultural group includes the Papago and related Pima of the southwestern Arizona desert, and the Yuman-speaking tribes of the Colorado and Gila rivers. Little is known of the history of these groups save that the Pima and Papago, at least, probably represent the descendants of the ancient Hohokam people of the region. Although the Ranchería tribes were farmers, they depended perhaps equally upon wild products, particularly the "mesquite bean," as well as upon small game and fish. Fixed villages were occupied, but the population shifted from one locality to another in accordance with the seasons. Generally speaking, arts and crafts were indifferent and rudimentary, and vastly inferior to Pueblo products. Social organ-

ization was characterized by rather weak clans that traced descent through the father, and political organization by chiefs who were accorded considerable prestige, but had little actual power. All peoples of the area possessed a strong sense of nationalism as well as a warlike tradition, especially elaborated among the Yuman tribes, where it achieved the character of a national sport. The religion of the Ranchería tribes was cast in the shamanistic rather than in the priestly tradition, and everywhere—although with varying local emphasis—dreams furnished the basis of supernatural power. All indulged in formal orations delivered on all ceremonial occasions, and believed in the magical powers inherent in songs and singing.

Although basic culture was essentially similar throughout this arid desert region, certain culture patterns differentiated the Pima and Papago sharply from the Yumans. Both the former cultivated cotton in addition to food crops, and the Pima practiced irrigation on a considerable scale. While weaving and pottery fell below Pueblo standards, both the Pima and Papago were expert basket makers, and traded their products with the less skilled Yumans. Owing either to Pueblo or ancient Mexican contacts, the Papago and Pima possessed a more complex religion which was preoccupied primarily with the bringing of rain to the parched fields. Ritual elements included a ceremonial enclosure, shrines, altars, offerings, as well as masked dances. A major rite was the saguaro festival, during which quantities of liquor made from fermented saguaro cactus fruit were consumed.

Built on much the same cultural base, the Yuman way of life was oriented somewhat differently. The Yuman tribes concerned themselves with the esoteric, and emphasized dream experiences and death. All professional statuses, all success, and all power were achieved through dreams, while ritual, ceremonialism, and other external trappings of religion were rudimentary or absent. Especially characteristic of the Yumans were the elaborate song cycles, ostensibly learned in dreams, that related the dreamer's adventures and excursions into the remote mythological past. Public ceremonials centered around complex funeral rites involving cremation of the dead, singing, and numerous formal orations. The mourning commemoration rite, accompanied by mock warfare, also represented a major cultural interest.

Pima baskets.

The primitive Walapai and Havasupai, while linguistically related to the River Yumans, are included in the Southwest merely on the basis of their geographical location. Although they occupied the Grand Canyon region of northwestern Arizona, their traditional way of life more closely resembled that of the hunters and gatherers of the California-Intermountain area. Both tribes, save when they were planting their crops on the watered canyon bottom lands, led a scattered, migratory existence, collecting wild seeds and nuts and hunting small game. Arts and crafts were meager; social and political organization was of the simplest; and ritual and ceremonialism were unelaborated. While they were to a very slight degree influenced by the Pueblo peoples, with whom they carried on trade, their cultural ties lay rather with the west.

Although Southwestern culture, particularly that of the Pueblos, represents one of the highest achievements of North American Indian civilization, it appears to have exerted surprisingly little influence upon surrounding areas. Some southern California tribes made pottery and possessed altars, sandpaintings, and other elements of ritual that unquestionably show Southwestern influence, but nothing approaching the complexity of Pueblo culture existed in this region. Yet archaeology demonstrates that at the beginning of the Christian era the remote ancestors of the Pueblo Indians, the so-called Basketmakers, possessed a culture in many respects like that of the primitive hunting and gathering tribes of the California-Intermountain area.

Havasupai mother and child.

CALIFORNIA-INTERMOUNTAIN

To the west of the Rocky Mountains, the lofty range that forms the continental divide of the North American land mass, lies a vast wilderness of deserts and mountains. The largest portion of this area, known as the Great Basin, covers much of the states of Nevada and Utah, and extends northward into Oregon and Idaho. Most of this great interior drainage basin, enclosed between the Rockies to the east and the Sierra Nevada-Cascade ranges of the western seaboard, consists of deserts, salt flats, and saline lakes, sparsely covered by sagebrush, juniper, and piñon, with occasional stands of pine. To the north, the Great Basin rises in elevation to merge with the forests and meadows of the plateau at the headwaters of the Columbia and Fraser Rivers. These two regions, Basin and Plateau, have been designated jointly as the Intermountain area. In pre-Columbian times the arid Basin, poor in both game and plant resources, supported a small and scattered population, while the Plateau, rich in salmon streams, was more densely inhabited.

Westward, and across the Sierra Nevada Mountains, the region today known as California was something of a primitive paradise. Although the climate of much of this area is semi-arid, the grasslands and marshes of the great central valley abounded in game, and the rolling hills were covered with groves of acorn-bearing oaks. The Pacific coast furnished fish, sea mammals, and shellfish in quantities. Encircling the central valley to the east and north, and separating California from both Basin and Plateau, rise mountains forested respectively with pine and redwood. In aboriginal times, owing to the wealth of natural food resources, California was one of the most densely populated regions in North America.

The most crucial factor in the culture history of the California-Intermountain area has been its isolation behind barriers of mountains and deserts, and the inability of much of the region, because of winter rains, to support maize farming. It is true that Southwestern culture influenced the peoples of extreme southern California, that the northern portion of the area, including the coasts of Oregon and Washington, were culturally outposts of the Northwest Coast, and that—in historical times, at least—the

Above: Yokuts basket decorated with quail plumes.

Wooden paddle for stirring acorn meal mush. Yurok.

westward-moving Plains tribes encroached upon the eastern fringes of both Basin and Plateau. Central California and the interior of the Basin, however, remained to a large extent cut off from cultural developments in other parts of the continent throughout the range of native history. Indeed the Indians of northern California were not disturbed to any great degree by the White man until 1850, and the last "wild" Indian was discovered as late as 1911. Owing to their isolation, therefore, the peoples of the California-Intermountain region remained backward and retarded, and although the well-fed Indians of central California developed some cultural elaborations and refinements of their own, these failed in large part to spread to tribes in less favored situations.

In early historical times the Basin was the stronghold of primitive Uto-Aztecan peoples, of whom the Paiute tribes are typical. To the north, the Plateau area was inhabited principally by such Salish-speaking peoples as the Okanagon, Shuswap, and Lillooet Indians, while other Salish tribes extended to the coast in the neighborhood of Vancouver Island, and from there southward toward the Columbia River. Other Plateau groups, related in culture, spoke dialects of the Shahaptian language. Although the native population of California was divided into many small tribal groups speaking a large number of unrelated languages, the Yokuts and the Maidu of the central valley, as well as the Pomo to the west, may be taken as representative.

Except that they all shared a primitive mode of life, the various tribes of the California-Intermountain area did not possess a culture that was uniform in all details. They were alike, however, in their general methods of exploiting the environment, for all lacked agriculture, and instead gathered wild seeds and nuts, supplementing this diet by hunting and fishing. Acorns supplied the staple food of the California Indians. These were prepared by grinding them in a stone mortar, washing the flour in a basin of sand to remove poisonous acids, and finally by boiling the mush in a water-tight basket with hot stones. The Paiute and other Basin peoples depended more upon wild seeds, which they collected with the aid of basketry seed beaters, and also upon the nuts of the piñon tree. The vegetable food of the Plateau Salish consisted largely of wild camas bulbs, and of berries.

California Indian village of the mid-nineteenth century. After a painting by Arthur Jansson.

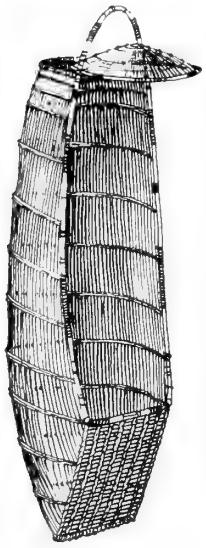
Pomo burden basket.

In addition to gathering acorns, the tribes of central California hunted deer by driving the animals over cliffs or past hidden hunters armed with bows and arrows. At times hunters disguised themselves as deer in order to crawl within shooting range. Rabbits were frequently driven into nets, quail were trapped and snared, and ducks were lured with decoys placed in the marshes. These tribes also fished with harpoons, nets, and hooks, often using canoe-like reed boats for this purpose, and collected shellfish along the Pacific coast. The Basin peoples held communal rabbit hunts in the fall during which hundreds of animals were driven into long nets, where they were killed with clubs. In the spring the members of several bands assembled to hunt antelope, an event that also marked an important social occasion. Here and there fish were hooked, drugged, or shot with arrows. Because of the scarcity of food throughout most of the Basin, the impoverished tribesmen not infrequently resorted to rats, reptiles, grubs, and insects. Tribes of the more favored Plateau area to the north depended primarily upon salmon, which they pulverized in the Plains fashion with berries and dried for future use, and upon deer.

With few exceptions, arts and crafts were poorly developed throughout the area. Except in southern California, pottery was lacking, as was true loom weaving. Although mats, nets, and netted bags were widely made, the craft in which the Indians of the California-Intermountain region excelled was basketry. Those made by the Pomo especially, which were often decorated with handsome geometric patterns, feathers, and

Yurok girl of northern California in festive costume. Late nineteenth century.

Basketry cradle with sun shade. Hupa.



beads, are among the finest in the world. In addition to containers for cooking, storing, or transporting food, articles manufactured of basketry included cradles, traps, hats, and seed beaters. Owing to influences from the Northwest Coast, the Salish tribes, especially those of the coast, carved in wood; throughout the Plateau area the use of containers and, occasionally, of canoes manufactured of bark reflected contact with the forest tribes of interior Canada.

The dress of most California and Basin tribes was extremely scanty. Men often went about entirely naked, or wrapped a strip of skin around their waists, while women wore only two-piece apron-like skirts of buckskin, fibers, or seeds, and basketry skull caps. Hide moccasins or fiber sandals were ordinarily used only for travel, and fur robes or woven rabbit skin blankets served as protection in cold weather. Men and women alike wore a variety of seed and feather ornaments as well as shell beads that in addition served as money. The Salish peoples of the Plateau were more adequately clothed in deerskin garments, and a special type of heavy leather armor was worn in combat.

Throughout most of California and the Basin houses were extremely simple in design, consisting of temporary structures of poles covered with bark, rushes, or earth. In the north the more substantial plank houses of the Yurok and Hupa, like the wooden dugout canoes used by those tribes, show Northwest Coast influence. Most of the central California villages, however, had one or more special structures, often constructed partially underground and roofed with logs and earth, that served as dance houses, clubhouses, and as dormitories for the men. Such semi-subterranean dwellings, entered through the smoke hole in the roof, were the winter residences of the Plateau tribes; in summer these peoples camped in mat or reed-covered tents.

Although in some parts of California the Indians were organized into clans that traced descent in the paternal line, complex social groupings were usually absent. The typical community consisted merely of a band of related families that inhabited a well-defined territorial range. In such a group civil affairs were supervised by a chief whose office was often hereditary or, as in the north, based upon wealth and prestige. In the Basin the size of the group depended mainly upon the adequacy of the food supply, although throughout this area the family was the basic social unit. A winter camp consisted of a few related families headed by a family leader. Owing to a more secure food supply, Plateau groups were somewhat larger, and bands of related families, led by hereditary chiefs, occupied permanent winter villages.

Except in parts of California, religion and ceremonialism were extremely simple, and religious activities centered chiefly around rites for adolescent girls, initiation ceremonies for boys, and the curing and weather-controlling activities of the shaman, or medicine man. Especially typical of central California was the rite held to initiate boys into the secret tribal society for adult men. This ceremony involved formal and prolonged education of the novice, followed by four days of dancing in the village dance house, during the course of which the performers, dressed in splendid feather costumes, impersonated returned ancestor spirits and mythological characters. The most important rites of the Yurok, Hupa, and other tribes of northern California, on the other hand, were associated with salmon fishing and the display of wealth. In these and many other respects the peoples of northern California, as well as those of the Plateau, were much influenced by the unique and colorful culture of the Northwest Coast.

Carved antler money box and bone spoon. Yurok.

NORTHWEST COAST

Geographically as well as culturally, the Northwest Coast is one of the most clearly defined areas of North America. Extending along the Pacific coastline from southern Alaska to northern California, the region is one of innumerable islands and sheltered inlets, of bays, and narrow beaches. Long arms of the ocean cut deep into the land to alternate with rivers and rushing mountain torrents. Rugged mountains, covered with dense forests of hemlock, cedar, spruce, and fir, rise abruptly from the beaches, isolating the coastal strip from the interior of the continent. Because of this difficult, broken terrain, nearly all travel on the Northwest Coast was by water. The climate is rainy and humid, with fog and mist along the ocean, and heavy snowfall in the higher mountains.

For reasons of topography, Northwest Coast culture was oriented toward the sea, and all tribes from the Tlingit in the north to the Nootka in the south derived their livelihood from the ocean. The sea afforded them an abundance, a degree of economic security, and a measure of leisure denied to all North American Indians save the agricultural peoples of the Southwest. The ocean and rivers teemed with fish, salmon alone furnishing an almost inexhaustible food supply. In addition, shellfish were collected along the beaches, while sea mammals were hunted from sea-going wooden canoes in the bays and inlets. The Nootka even harpooned whales in the open ocean. This staple diet of sea food was supplemented by the gathering of roots, bulbs, and berries, and by the hunting of deer, elk, mountain goats, and other land animals in the interior.

The fishing and hunting devices of the Northwest Coast Indians were varied and ingenious. Fish were taken in nets, traps, and weirs, as well as with rakes, spears and harpoons, and many specialized types of hooks. Hunting implements consisted of traps, snares, and the bow and arrow for land mammals, and harpoons for seals, porpoise, and whales.

Not only was the food supply of the Northwest Coast more plentiful than elsewhere on the North American continent; techniques of drying and smoking fish, meat, and shellfish, as well as methods of extracting fish oil that could be stored for years, enabled

Above: Tlingit mask representing the moon.

Some types of Northwest Coast fish hooks.

these Indians to accumulate large food surpluses for the winter months and for the lavish feasts required on numerous social and ceremonial occasions. Although some fish were eaten raw, most foods were either roasted or were boiled or steamed in wooden boxes with hot stones. Food was served in carved wooden platters and bowls, and eaten with horn or wood spoons.

Just as the sea furnished an abundant food supply, the forests along the shore supplied the Indians with quantities of raw materials. The beautiful, straight-grained woods were used for building houses and canoes, as well as for numerous utensils, ceremonial objects, and other carvings. The inner bark of the cedar tree, beaten to a fine fiber, furnished material for clothing, rain coats, and bedding, while the outer bark was woven into mats. Cedar and spruce roots supplied materials for basketry, weirs, and cordage.

By far the most important industry on the Northwest Coast was woodworking. Since trees were frequently blown down by storms or washed out by floods, it was usually unnecessary to expend labor in felling them. Once fallen they were split into planks with wedges and shaped by means of knives, drills, adzes, and chisels of shell, bone, stone, or antler. Special features of Northwest Coast woodworking included the bending of boards by steaming, and the joining and mending of wood by sewing with spruce roots or some other material. Objects manufactured of wood varied in size from minute ornaments and figurines to great dug-out canoes 60 or more feet in length, and capable of carrying 50 or 60 men. Other articles made of wood included boxes for cooking and storage, bowls, dishes, ladles, clubs, staffs, masks, rattles, totem poles, and grave monuments.

Carved and painted wooden food box representing a bear. The eyes, teeth, and rim ornaments are of shell inlay. Tlingit.

Model of a Kwakiutl village of the mid-nineteenth century.

In addition to wood, some carving was done in stone, bone, ivory, and horn, and the latter material was also steamed and bent to manufacture dishes and spoons. Carving, in fact, became a passion of the Northwest Coast peoples, and Tlingit and Haida artisans decorated with carvings and paintings such utilitarian articles as paint brushes, awls, chisels, and the like. Although pottery was altogether absent, and although true metallurgy was lacking prior to White contact, some Northwest Coast tribes, particularly the Tlingit, were expert weavers and basket makers. Since wool-producing domesticated animals were unknown, weaving was done in a combination of cedar bark and mountain goat hair augmented by dog hair, as in the famous Chilkat blankets. Articles manufactured of basketry included cooking and storage containers, fish traps, and hats.

Northwest Coast houses differed somewhat from tribe to tribe, but all were imposing square or rectangular structures of great wooden posts and beams, with cedar planking for walls and roof. Large houses could accommodate several related families, each of which was assigned its special living space inside. In accordance with the status system of the area, the family of highest rank occupied the position farthest from the door. The fronts of these houses were painted with heraldic designs, and a totem pole erected at the doorway proclaimed the clan affiliations of the family within.

The mild, humid climate of the Northwest Coast made warm clothing unnecessary. Men went about entirely naked during the summer months. During winter, and especially on ceremonial occasions, they donned skin kilts and shirts, as well as fur robes or woven blankets. Women customarily wore apron-like skirts of shredded cedar bark, and twined-woven capes of the same material. Footgear was almost entirely lacking, and hats were worn chiefly as protection against the rain. Members of both sexes adorned themselves with ear and nose ornaments of shell, bone, wood, and other materials, while the women of some tribes slit their lower lip and inserted a grooved wooden plug. Artificial deformation of the head was also considered a mark of beauty by some peoples of the area.

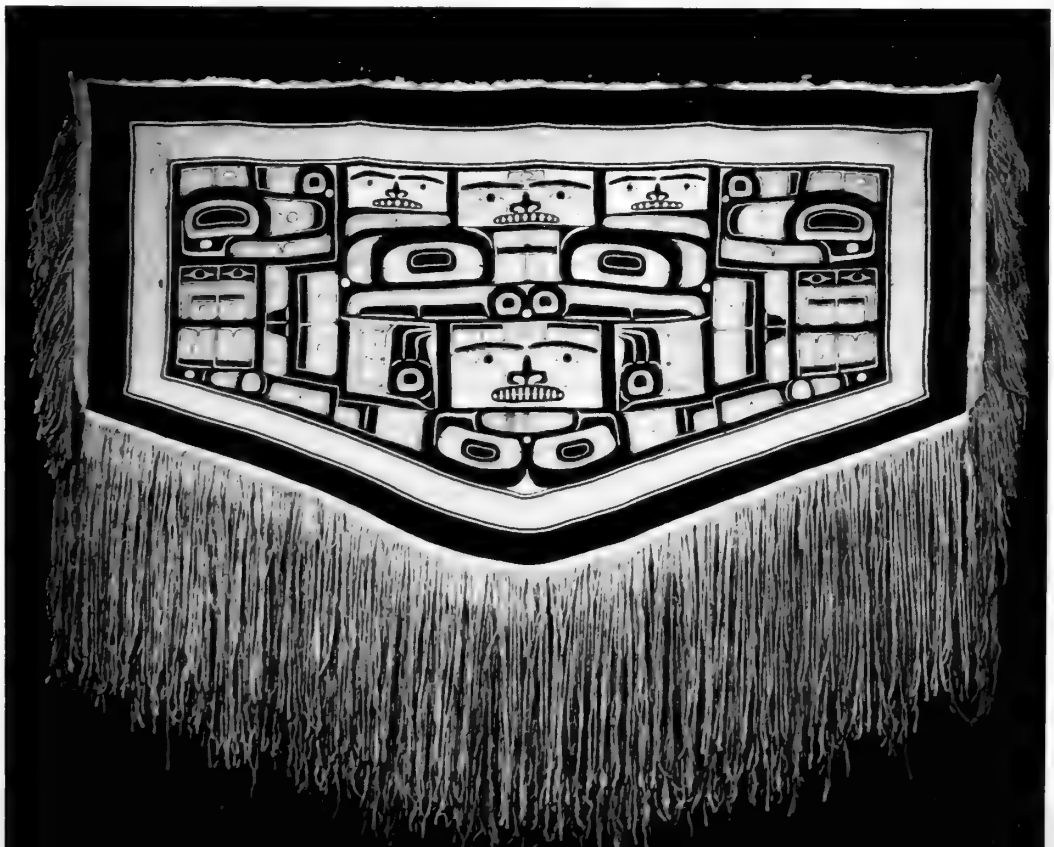
Throughout the Northwest Coast there was little feeling of tribal unity. Instead, the principal social and political unit was the village, consisting of a single row of houses built along the beach of a sheltered cove. Villages speaking the same language were, nevertheless, linked together by means of a clan organization. The northern peoples traced descent through the female line, while the Kwakiutl and other southern tribes reckoned it through the father.

Most characteristic of Northwest Coast society was the great emphasis placed upon rank. Although social status was based in part upon family connections and ancestry, rank depended even more upon wealth and property, so that individuals and families could rise and fall through actions of their own. With the exception of certain types of shell money of fixed value, true currency was lacking. Wealth, therefore, was defined in terms of such tangible property as canoes, blankets, slaves, wood carvings, and certain shield-shaped copper plates, the value of which depended upon their history and the amount for which they had been sold. Other property consisted of intangibles, such as privileges, titles, names, and the exclusive rights to certain dances, songs, and rituals.

In each village there were one or several families of wealth and aristocratic blood who consequently dominated the community in which they resided. At the top of the social ladder were the wealthy chiefs, with their closely related kinsmen only slightly below them. Next in rank were the poor relations of the nobility, who were usually hangers-on in their households. There was also an ill-defined middle class of persons who, while not of high birth, were free men and possessed some worldly goods. The bottom of the social hierarchy was occupied by the slaves, who were captives taken in war or purchased from other tribes. With the exception of this last group, it was possible to raise one's self in the social scale, either through marriage with a person of rank, or through the accumulation of property.

Constant attempts were made by a chief or a person of high rank to better his status and increase his prestige at the expense of his rivals. One of the principal ways both to elevate one's position and to shame a rival was to give a large feast at which valuable property was publicly and ostentatiously destroyed. A fine canoe, for example, might be wilfully chopped to pieces, or precious stores of fish-oil deliberately poured out and burned. A more extreme act was to break a costly copper plate, and throw the pieces into the sea, as though such a loss meant nothing to the owner.

Chilkat blanket worn by men of rank on ceremonial occasions.



Central not only in these incessant contests for prestige, but also in the entire economic system of the Northwest Coast tribes, was the *potlatch,* a ceremony involving a great feast during which valuable property was distributed to the assembled guests. In addition to enhancing the host's fame and social standing, the *potlatch* guaranteed him economic security, since those who received the gifts were obliged at some future date to return them with interest which at times amounted to 100 per cent. Although the chief reason for the *potlatch* was to raise the social position of an individual and his family through the distribution of goods and the display of wealth, the occasions on which these lavish feasts were given varied from tribe to tribe. Some held the *potlatch* to celebrate puberty rites, others to consecrate a new house, and still others, like the Haida, to commemorate the death of a relative.

Among the Tlingit and other tribes, the shaman rivaled the chiefs in power and prestige. Each medicine man possessed a supernatural helper who gave him magical power and whose mask was worn when the shaman was curing a sick patient. Shamans were believed to have the power to send their souls on magical flights, and to see the cause of disease. In addition to curing they were believed able to foretell events, and consequently accompanied war parties in order to warn of danger and to assist in destroying the enemy through the use of magic.

The Northwest Coast peoples believed in a bewildering number of supernatural beings, the great majority of which were nature deities, including the spirits of fish, land and sea mammals, and birds. In many ways these beings were thought to resemble humans, and regarding their activities the Indians related innumerable myths and tales. Northwest Coast ceremonialism consisted essentially of reenactments of these legends.

Throughout the Northwest Coast area there were secret societies that performed dramatizations of myths during the winter months. At this time supernatural beings were believed to visit the villages to dwell among mortals. In impersonating these spirits, elaborate costumes and settings were employed to achieve complicated dramatic effects.

Although these ceremonials were predominantly religious in character, they also had entertainment value as theatrical performances. They were usually accompanied by feasting, singing, dancing, and the distribution of property. To the uninitiated the masked performers appeared to be possessed by supernatural beings, and at this time they were thought to be able to perform miracles. The Indians believed that the novices who joined a secret society were taken to the houses of the spirits, who gave them songs and instructions, and caused them to behave in an insane and violent manner.

Carved ivory shaman's charms. Tlingit.

Carved wooden mask with copper eyebrows. Tlingit.

Northwest Coast art can only be understood in connection with the prestige system and the rich ceremonialism that it was made to serve. Although some realistic examples of the art probably represent actual portraits of people and animals, most of it—whether carved in the round, in relief, or painted—is of a conventionalized heraldic and symbolic nature. Totem poles, for example, were intended to illustrate myths or to show the clan affiliations of a family. In order to suggest a narrative or a combination of ideas, the artist therefore took liberties with the anatomy of the animals depicted, and often represented them by a significant part rather than by the entire figure. Thus a beaver was symbolized by its teeth or tail, a bear by its claws, and a hawk by its curved beak. Similarly, the masks worn in ceremonials did not represent actual animals, but supernatural creatures with human attributes.

The artist also adapted his animal designs to the shape of the object he intended to decorate. In such cases the animal was often dismembered and the parts arbitrarily rearranged to form a pleasing design. At times its internal organs were also shown, and were artistically adapted to the design area. Exotic and unfamiliar though it is, Northwest Coast art represents one of the most striking and original artistic contributions of the primitive world.

Although Juan de Fuca sighted the Northwest Coast in 1592, the first landing appears to have been made by the Russian explorer Behring in 1741. By the late eighteenth century, fur trade with the Indians was firmly established, and this industry had great influence on their lives. In a society where economics already played so important a role, the sudden acquisition of wealth through the fur trade could only result in a great increase in creative activity. Thus within the span of some two centuries, Northwest Coast culture reached a sudden and brilliant climax, only to be destroyed by the advance of modern technology.

EASTERN–NORTHERN

The term "Eastern-Northern" as used here to designate a culture area refers to that ill-defined transcontinental tract of forested country flanking the grasslands of the plains to the north and east. In extent it includes nearly half of the North American land mass, embracing almost the whole of its Atlantic and Arctic drainage.

In contrast to western North America, this extensive area is characterized by a lack of topographical and geological extremes. To the east of the Rockies there are no massive mountain chains, nor even a plateau of great elevation. Nearly everywhere summers are hot and the winters are cold, or at least uncomfortably raw. Temperature varies with the season, however, with rainfall distributed throughout the year. Nowhere is there anything to compare with the wet, humid forests of the Northwest Coast, the arid deserts of the Southwest, nor the dry summers and rainy winters of California.

On the basis of vegetation and the nature of the forest cover, this wooded zone may be divided into two major sub-regions. Before the coming of the White man the eastern area was one of predominantly deciduous forests, interspersed with stands of evergreens; here favorable growing seasons permitted the Indians to make clearings in order to plant fields of maize, beans, and squash. The north, on the other hand, from Nova Scotia to Alaska, was prevailingly a region of evergreen forest of spruce and fir which, owing to short summers and early frost, was unsuited to the cultivation of indigenous plants of tropical origin. It was in large part the presence or absence of agriculture that accounted for the basic regional differences in Indian life within the Eastern-Northern area.

Like the physical environment, the native culture of this forested zone was characterized by a lack of sharp definition. Save in the southeast during late prehistoric times, nowhere was there a cultural development so complex and distinctive as that of the Southwest or the Northwest Coast, nor—except in the extreme northern tundra to the south of the Eskimo—anything so primitive and simple as that typical of the California-Intermountain area. Yet the various cultures that have been classed together by anthropologists within the geographical confines of the Eastern-Northern area were by

Above left: Chitimacha splint basket; right: engraved birch bark container, Montagnais.

no means uniform in level of complexity. Although many tribes of eastern and northern North America were exterminated, altered, or displaced soon after the arrival of the first European colonists, the general outlines of the cultural picture at the time of first White contact seem reasonably clear.

The northern forest zone was occupied by primitive hunters who spoke languages belonging to the Athabascan or Algonkian stocks, while the southeastern United States was inhabited by speakers of Muskogean and Caddoan, as well as by tribes pertaining to smaller, isolated language families. These peoples practiced intensive agriculture, but also hunted and fished. In between these two well-marked, contrasting areas, in a broad band that extended from the eastern plains and the Great Lakes region to the New England coast and southward into the Mississippi Valley, lived a number of tribes who combined hunting, fishing, and farming in varying degrees. Some of these marked regional differences in culture were dictated in large part by the environment, while others resulted from historical events that must be considered very briefly.

At some time during the ninth century A.D., strong cultural influences from Mexico penetrated the southeastern United States and, spreading rapidly northward, largely replaced the earlier "Woodland" culture in the lower reaches of the Mississippi Valley. Prior to the period of Mexican influence, the aborigines of the eastern area had already acquired farming from some tropical American center, although they seem to have depended equally upon game and fish. Also typical of this earlier Woodland culture were a number of traits that appear to have been introduced into the area from the north, and that are probably of Asiatic origin. These included the practice of burying the dead beneath earth mounds, the manufacture of cord-marked, pointed-bottomed pots, the use of copper tools and ornaments, and, perhaps, semi-subterranean dwellings as well. Although the Mexican-derived culture, which archaeologists have called "Mississippian," replaced Woodland in the central valley of the Mississippi, elements of the earlier culture lingered on into historical times in certain isolated areas of Virginia and the Carolinas, as well as among some Great Lakes tribes, and elsewhere.

The peak of Indian civilization in the eastern United States was achieved during the period of Mexican influence. In the lower Mississippi Valley, populous villages and carefully tended fields clustered around large ceremonial centers which were also the seats of miniature "kingdoms," and the capitals of high-ranking chiefs. These centers consisted of rectangular pyramid mounds, topped by temples and other important structures, carefully grouped around plazas. The most characteristic feature of this highest southeastern civilization was its complex political and military organization, which in turn probably accounted for its rapid growth and spread. Here alone on North American soil did the Indians achieve something approaching the great states and empires of ancient Mexico and Peru. Yet although some fine painted and incised pottery was made during this period, ceramics, textiles, and architecture remained below Southwest standards, and the art of carving probably never equalled that of the Northwest Coast.

Even though the highest expressions of Mississippian civilization were confined mainly to the southeastern United States, influences penetrated as far north as New York, New England, and the Great Lakes where, among the Iroquois, Menomini, Winnebago, and other tribes, they were merged and combined with earlier Woodland patterns. It is essentially a combination of Mississippian and Woodland culture elements that underlies the historical horse-culture of the Plains.

The flowering of Indian civilization in the southeast is known principally through archaeological remains. At its peak it was glimpsed and described briefly by chroniclers who accompanied the Spanish exploratory expedition of Hernando de Soto in 1541. Nearly a century and a half later, however, when the southeast was rediscovered by the French missionaries Joliet and Marquette, this culture had collapsed, and great areas were entirely abandoned, the population doubtless wiped out by epidemic diseases of European introduction.

Other Indian populations of Eastern North America shared a similar fate. Those inhabiting the Atlantic seaboard were among the first to bear the brunt of intensive White contact, and many groups disappeared rapidly as a consequence. While the Mississippi Valley was being explored, the French sailed up the St. Lawrence River, built settlements and fortifications, and established the fur trade that was to bring about far-reaching modifications of native life. Trapping for the fur trade soon revolutionized the economy of the most isolated northern forest tribes.

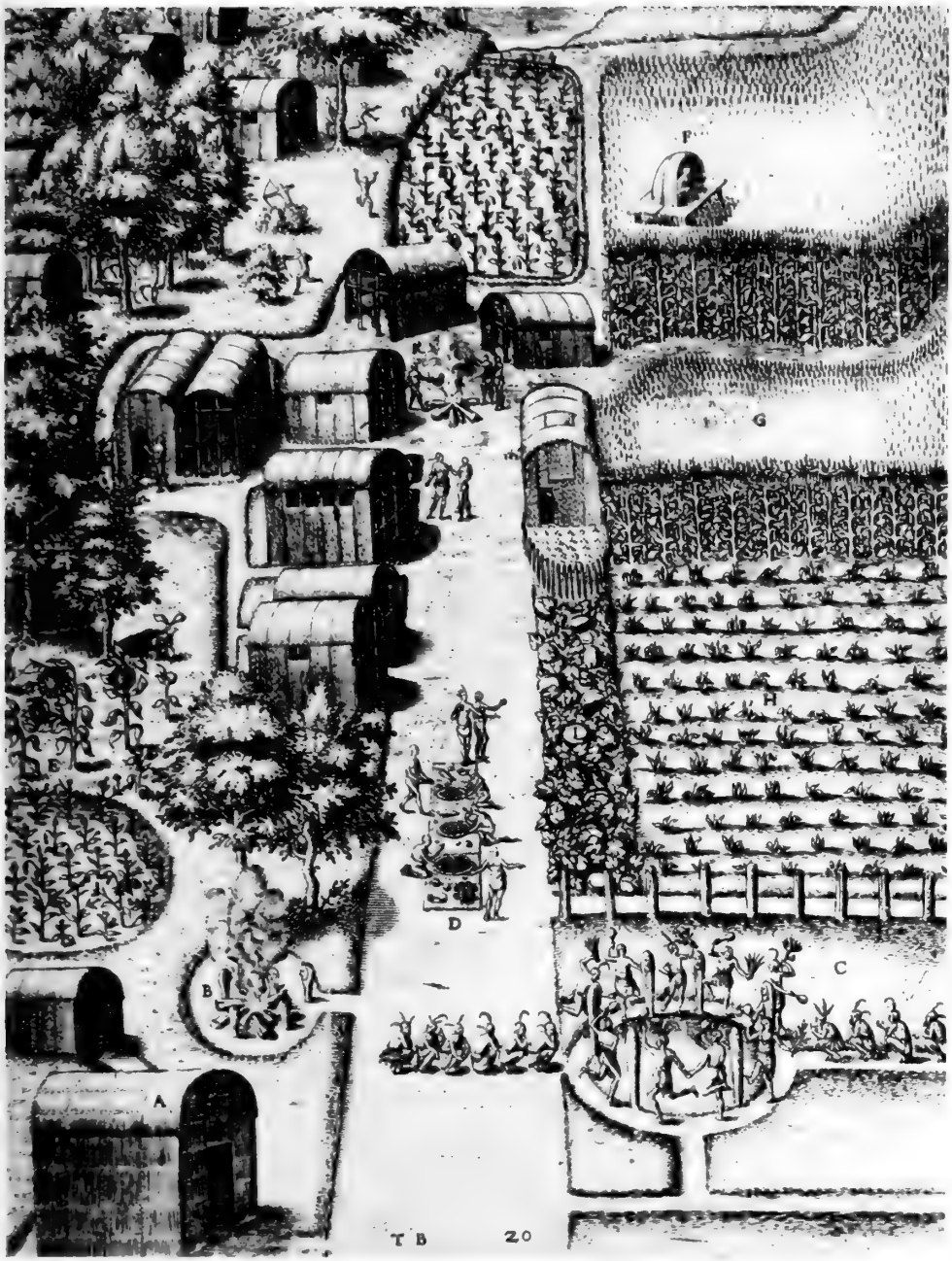
Early in the seventeenth century the English settled New England and the Dutch, New York. Although their relations with the Indians were at first peaceful, bitter fighting developed as the colonists began to expand inland. In the matter of attitudes adopted toward the European settlers tribe was set against tribe, and inter-tribal warfare flared as a result of population pressures caused by White encroachment on Indian lands. The effects of these disruptions of tribal life were gradually felt far beyond the established frontiers, eventually extending—although in diminishing degree—as far west as the Great Lakes and the plains. In brief, epidemics, warfare, and trade with the White man had produced great changes in the way of life of many tribes, particularly those of the east, long before these Indians were first described by travelers and scientists.

THE EASTERN AREA

By about 1700, a generalized, simplified version of late Mississippian culture prevailed throughout much of the southeastern United States, and it is this way of life that is represented by the historical Creek, Choctaw, Chickasaw, Natchez, and other tribes of the area.

The great ceremonial centers noted by de Soto's chroniclers had disappeared. Instead, many tribes, like the Indians of the Gulf Coast, lived in scattered neighborhoods and retreated to fortified stockades when danger threatened. In Creek villages the streets led off a centrally located plaza which was occupied by a council house, or rotunda, a public square, and a ceremonial ball field. In some towns frequently threatened by war, the houses and plaza were crowded within palisaded walls. Other groups walled only the chief's house and the sacred buildings.

Although details of house construction varied considerably from tribe to tribe, most were built of such light, perishable materials as palmetto, cane, reeds, bark, or grass. Some were square with wicker walls and gabled roofs of thatch or bark, while others were round or dome-shaped. The Creek, Chickasaw, and their neighbors had separate summer and winter dwellings, the former being essentially open pavilions with porches. Along the Atlantic seaboard the Indians built multi-family "long houses" of the Iroquois type, with partitions separated by mats. Throughout the southeast houses were furnished with skin-covered frame platform beds, and carved wooden stools.



Early engraving of a North Carolina Indian village. Thomas Hariot, 1588. The original caption locates the following features: A—bone house; B—prayer ground; C—dance ground with carved posts; D—plaza for feasting; E—tobacco patch; F, G, H—corn fields in different stages of growth; I—pumpkin patch; K—sacred fire; L—river bank. "J" appears neither in the original caption nor drawing.

Although, generally speaking, sacred buildings were not differentiated, the Creek and Cherokee constructed large round council houses which in addition served as clubs for the men, and as dance houses. The Creek also had a summer ceremonial structure of four sheds facing the sides of a square.

Farming was general throughout the southeast. In historical times, however, agriculture played a less vital role in the total economy than in the Southwest if, indeed, it had ever been so important. Corn, beans, squash, sunflowers, and tobacco were planted in clearings in the forest, where the men girdled the trees, burned the brush, and prepared the soil, while women tended the growing crops. Farm implements consisted merely of hoes with blades of bone or stone, and of planting sticks. Such wild foods as roots, water lily seeds, marsh potatoes, berries, and persimmons, which were dried to make a bread, also contributed importantly to the vegetable diet. In addition, nuts were gathered and maple sugar prepared in the higher regions.

Hunting and fishing ranked, perhaps, equally with farming. Although the bison had disappeared from the southeast at an early date, deer were stalked by single hunters, or were occasionally surrounded during drives. The most common method was for the hunter, disguised in deer skins and antlers, to shoot the animal at close range with bow and arrow. Small game and birds were taken by means of blowguns and cane darts. Alligators, turtles, and some snakes were eaten, while bears were hunted chiefly for their fat. The only animal universally domesticated throughout the region was the dog, and some tribes bred small varieties for eating.

Fish were available everywhere, and were taken with hooks, shot with arrows, or speared. In the interior, pools and ponds were drugged with a narcotic derived from buckeye, while weirs and fish traps were confined mainly to the coast. Wherever they were available, shellfish were collected and these, as well as surplus fish and meat, were dried and stored in special storehouses along with the harvested crops.

Owing to regional differences in the availability of foods and raw materials, intertribal trade was well developed in spite of the incessant wars. Coastal peoples traded dried shellfish and sea shells for hides, flint, red paint, and arrow canes from the interior. In addition to barter, some type of shell currency seems to have been aboriginal in the

Natchez pottery, about 1700.

southeast. During historical times wampum, or strings of shell tube beads that varied in value according to the color and length of the string, was introduced into the southeast from the region of New York and southern New England, where the Indians manufactured it in quantities. So high was the value placed upon wampum by the historical tribes that almost anything, murder included, could be purchased with it.

In many respects the arts and crafts of the southeast closely resembled those of tropical America, and most of the articles produced were made of perishable materials, few of which have survived. Mortars and pestles used for grinding food were of wood, as were seats, bowls, ladles, and spoons. Most canoes were dug-outs, hollowed with the aid of fire from large cypress logs, although bark canoes were occasionally manufactured for temporary use, as were rafts. Cane splint and wicker basketry of tropical American type was highly developed, especially among the Choctaw and Chitimacha. Weaving, however, was of less importance and was confined to bags, mantles, bands, and ornamental garters woven of pounded mulberry bark. Pottery making was general, but declined rapidly in quality during historical times.

Tattooed warrior of the Florida coast. Water color by John White, about 1585.

The southeastern costume likewise resembled that of tropical America in several respects. Men wore a breech clout of buckskin or braided palm fiber, supported by a girdle of hide or snakeskin. For dress occasions they donned mantles and crowns of feathers. Chiefs and nobles wore headbands of skin, replaced during the early historical period by cloth turbans or silver crowns. During cold weather buckskin leggings were worn, and moccasins of the same material were used for travel.

The feminine costume consisted of a short skirt of buckskin or, in Florida, of Spanish moss, and a cloak woven of mulberry fiber. During cold weather both sexes wore heavy robes of bear, otter, or beaver skin which were occasionally adorned with porcupine quillwork decoration.

What the southeastern peoples lacked in the way of clothing they made up for by their extensive use of ornaments, fashioned of feathers, beads, bones, copper, stone, and shell. Anciently pearls were worn by chiefs and nobles, although in later times ornaments of silver and brass were adopted as well. In addition, the southeastern Indians paid great attention to the decoration of the body itself. Women blackened their teeth and men painted the skin for war, ball games, and for various social occasions. Tattooing

was practiced extensively, and although some marks and designs indicated tribal, clan, and family connections, most declared the individual's exploits in war. Elaborate methods of dressing the hair were devised which varied from tribe to tribe. Creek and Chickasaw men, like those of many northeastern groups, shaved their heads save for a crest or roach, while others shaved the top of the head, leaving a crown-like fringe around the edges. Most men throughout the area regularly rubbed their hair with a mixture of bear grease and red paint.

The southeast was one of the great areas in aboriginal North America where matrilineal descent prevailed. Typically a tribe or town was divided into a number of clans, each of which traced descent in the female line and was named after some animal, bird, or object—such as alligator, red paint, crane, or corn—which the clansmen regarded with special veneration. Land was owned, however, not by clans nor by individuals, but by the town or tribe as a whole, and was divided among the component members on the basis of their needs.

Among some tribes, notably the Natchez and Chitimacha, an aristocratic tradition persisted from earlier times. The Chitimacha nobility married exclusively among themselves. On the other hand, Natchez aristocrats, who were called "Suns," possessed the highest authority, but were compelled to marry among the common people.

Each Creek tribe—which usually corresponded to a town—possessed a civil chief who was in charge of all public and domestic affairs, who headed the tribal council, and acted as its spokesman. Each tribe was also headed by a war leader who in addition attended to the policing of the town, and supervised the ceremonial ball games.

Throughout the southeast the power of chiefs and nobles was great. They were permitted to take several wives, possessed special insignia of rank, were carried about in litters on public occasions, and when they died they were accorded spectacular funerals. Indeed the spouses of the nobility among the Natchez were strangled in order that they might accompany their deceased partners to the hereafter.

Although the miniature "kingdoms" of late Mississippian times had vanished at the dawn of the historical era, complex patterns of political organization persisted. Of special note were the confederacies of such tribes as the Creek, Choctaw, and Cherokee which probably represent the prototypes of similar institutions in the northeastern area, notably the famous League of the Iroquois. Originally each southeastern confederacy seems to have been a loose union of related tribes that banded together for mutual protection, but that remained, nevertheless, largely self-governing. Within a given confederacy, peace generally prevailed, for ball games scheduled between member tribes tended to reduce internal friction. The component tribes were, however, staunchly united in war against all neighboring groups. Each confederacy tended to be dominated by two or three important towns where special council houses existed and where, during meetings on matters of group welfare, the delegates were seated according to rank, and with great ceremony. The confederacies of the southeast, like those of the northeast as well, assumed greater importance in historical times, since they proved most effective in meeting and dealing with White opposition.

Warfare was a major preoccupation of the southeastern tribes and, considering North American Indians generally, wars were conducted in this region on a large and singularly vicious scale. War led to prestige and to personal glory, and warriors boasted of their exploits, tattooed the records of their valorous deeds on their bodies, and assumed names of a bellicose nature. In addition to prestige and honor, motives for war included retaliation against real or fancied wrongs committed by neighboring

groups, and, in the Carolinas, the desire to obtain slaves. As a result, most tribes lived in an almost constant state of war, and some were able to avoid total extinction only by the practice of adopting captives.

The weapons of war consisted of clubs of various types, and bows and arrows. Wicker or bark shields were carried for protection, and some tribes used wicker armor as well. Warfare was accompanied by great ceremony. Before embarking on a raid, warriors assembled in a temple or other special structure, where they painted themselves, performed magical rites, and took medicines. Attacks usually involved the element of surprise, and were often scheduled for dawn. At times the entire populations of enemy towns were massacred, including the women and children. The scalps taken were dried on frames, painted red, and displayed on poles during public occasions.

Some groups, like the Chickasaw, adopted women and children into the tribe. Adult men, however, were often tortured to death, usually by the enemy women. The heart of a courageous foe might be devoured by the victor, and a few tribes indulged in even more extensive cannibalism. While all successful military expeditions were concluded with a scalp dance, equal ceremony attended peaceful overtures. As in the Plains and in most parts of the northeast, the smoking of the *calumet*, or peace pipe, was an important ritual.

The tribes of the southeast were also especially concerned with death and the disposal of the dead. Corpses were exposed on a scaffold until the flesh had disintegrated. The bones were then cleaned by a special class of morticians known as "buzzard people," placed in a cane hamper, and stored in ossuaries, or "bone houses." In most parts of the area, these structures were sacred places. Among the Natchez and neighboring tribes, perpetual fires, renewed once a year, burned in the ossuaries reserved for the remains of chiefs and nobles.

Other less striking aspects of southeastern religion are known in far less detail. Most tribes appear to have believed in a supreme sky deity which, among the Natchez and their neghbors, was identified as the sun, from whom the nobility traced descent. In addition there existed a host of lesser spirits, as well as elves, giants, demons, and ghosts. Snakes, owls, and wolves, as well as animals associated with water, were regarded with fear and veneration, although even the bones of game animals were treated with reverence lest their spirit-owners become angry and withhold the game supply. Some ritual seems to have been associated with agriculture as well, since the greatest annual ceremony of most tribes was held at harvest time in mid-summer, when the first corn ripened.

Some deities of the southeast were represented by carved wooden images, to which offerings were made on various ceremonial occasions. Virginia Indians danced around certain carved wooden posts set in a circle, while other tribes danced around sacred fires. Offerings consisted of tobacco, which was offered to the sun, and of such other things as blood, deer fat, copper, and beads. A few tribes of the region practiced human sacrifice as well.

Regular priesthoods served the deities among the Creek, Natchez, Chichasaw, and other groups. Priests wore distinctive dress and insignia, and were required to pass through several degrees of training. The chief priest of the Natchez attended the sacred fire, while the duties of others were connected with the royal ossuaries. In addition to priests, a special class of shamans cured disease, while others disclosed the future by magical means. Still other specialists controlled weather, and practiced witchcraft and sorcery.

Indians of the Great Lakes region wearing roaches of moose hair. Maximilian, 1843.

The native culture of northeastern North America was basically an extension northward of the way of life just described as having prevailed in the lower Mississippi Valley and adjacent regions of the Gulf Coast. In its northern setting, which extended, roughly, from the Great Lakes to New England, it was modified in accordance with conditions imposed by a more rigorous environment. Here it also became fused with elements of the older Woodland culture, and with patterns more typical of the northern hunting tribes. It was in addition subject to influences that spread to the northern forests of America from sub-Arctic Siberia.

Linguistically and culturally this intermediate zone may be divided into three principal sub-areas. The Great Lakes region, centering around Lake Michigan, was inhabited by a number of tribes of whom the Siouan-speaking Winnebago and the Algonkian Menomini are, perhaps, best known. During historical times some tribes of the area, which adjoins the prairies, pushed westward into the plains. Others, like the Ojibwa, were crowded northward into the forests as a consequence of White encroachment and tribal dislocations.

The second sub-area, the region of the eastern Great Lakes, was the stronghold of the various Iroquois-speaking peoples who, because of their efficient military and political organization, became a group of considerable importance during historical times, and have survived in numbers to the present day.

The Atlantic coast, from New Brunswick to Virginia, was the homeland of Algonkian-speaking tribes who comprised the third sub-area. Except in the far north, disease and warfare combined to exterminate most of these Indians early in the historical period.

Throughout the northeast agriculture spread to the northern limits of efficient maize cultivation. Although the crops and techniques were, in general, those of the southeast, in much of the area farming played a subsidiary role. While the Iroquois grew crops on a large scale, Ojibwa cultivation was definitely secondary to hunting, fishing, and gathering.

Hunting methods were similar to those of the south, the Iroquois even employing the blow gun to some extent. Deer and bear were the chief game animals; the Great Lakes tribes, however, occasionally hunted buffalo as well. Wild fowl were also taken in numbers, and greater use was made of traps and snares for small game. The importance of fishing depended upon local conditions. Although sturgeon particularly were fished on the lakes, the coastal peoples depended more upon fish and shellfish, employing nets and seines in addition to the methods prevalent to the south.

Wild vegetable products were everywhere important articles of diet. In the Great Lakes area, the Menomini, Ojibwa, and Winnebago gathered an annual harvest of wild rice that grew so abundantly along the marshy edges of the lakes and rivers that the crop enabled the region to support a fairly dense population. Most tribes manufactured sugar by boiling the sap tapped from maple trees, and gathered nuts, roots, and berries.

Although houses followed southeastern models, most were covered with bark or mats rather than with cane and reeds. The Ojibwa, however, preferred the conical *tipi* more typical of the northern forests. Great Lakes tribes had separate summer and winter dwellings, and the villages of the Iroquois and some New England tribes were surrounded by palisaded walls. Typical of the Iroquois also were their great, rectangular "long houses," each of which housed a number of related families occupying separate, screened-off compartments.

Clothing was intermediate in type between the southern and northern areas. In addition to the leggings, breech clouts, and moccasins of buckskin, some men wore sleeved shirts of the same material. Women wore moccasins, short leggings, and occasionally one-piece dresses of skin in place of the more usual buckskin skirt. Fur or hide

Beaded bandolier bag with floral patterns typical of the northeastern and northern areas. Ojibwa.

robes for winter use were universal in the region. Anciently, the garments of men and women alike were decorated with appliqué designs of dyed porcupine quills, embroidered with moose hair, or painted. Quill decoration, however, was soon replaced by glass beads of European manufacture, often applied in intricate floral patterns of probable French origin. Similarly, cloth obtained from White traders at an early date took the place of deerskin. Even the pattern and cut of the native costume was rapidly modified along European lines, and metal rings, bracelets, and other ornaments soon came into general use. Indeed, by the end of the eighteenth century, the Iroquois themselves had become accomplished silversmiths.

The material culture of the northeastern tribes was essentially southeastern with northern modifications. Carved wooden mortars, containers, tools, and utensils were general, although numerous articles manufactured of elm and birch bark are equally typical of the area. Basketry, as in the southeast, was woven of splints, and weaving was confined almost entirely to mats, bast fiber bags, straps, and bands. Most tribes made some pottery which, among the Iroquois especially, shows affinities with the earlier Woodland variety. While log dug-out canoes were used to some extent, the fine, light birch bark canoes of northern type were more common in the northeast. Other articles showing northern influence included snowshoes and toboggans.

Social and political organization of the northeastern peoples likewise exhibited points of resemblance to the southeast. Generally speaking, families were grouped into clans and clans into tribes. Although political organization reached its greatest complexity among the Iroquois, where tribes in turn were grouped into a confederacy—the famous League of the Five Nations—lesser confederacies also existed in the Great Lakes region, as well as in New England. Like those of the southeast, northeastern clans were totemic, each being named after an animal or bird toward which the clan members exhibited special reverence. While the Iroquois and the Indians of southern New England reckoned descent through the mother, those of the Great Lakes and northern New England traced it chiefly through the male line.

Among many northeastern groups the members of a tribe united for purposes of warfare. The raids that they conducted against their enemies were accompanied by much ceremony, centering chiefly around certain sacred objects contained in medicine bundles that were thought to contain magical power. The concept of medicine bundles was particularly elaborated among the Great Lakes peoples whence, in all likelihood, it spread westward into the Plains. Again, as in the Southeast and the Plains, victory was celebrated with a scalp dance, and the Iroquois, like the southeastern warriors, tortured prisoners. Among this people warfare was undertaken by parties of men eager for glory rather than by the League as a whole, the latter organization being primarily of a civil nature.

Like the Indians of the Plains, the northeastern tribes believed in countless supernatural beings, many of them animal spirits, who revealed themselves to men in visions. People possessing personal power as a consequence of these revelations usually became shamans, and invoked their guardian spirits to cure disease, foretell the future, or to insure success in warfare. Religion and mythology also centered around belief in a supreme being, *Manitou*, although the personal guardian spirits seem to have played a more important role in the lives of these Indians.

In the Great Lakes region and among the Iroquois, ritual was somewhat more complex than elsewhere. The most important ceremonies of the Menomini, Winnebago,

Iroquois mask of the False Face society.

and neighboring tribes centered around the activities of the *Midewiwin*, a secret curing society having special songs, rites, and paraphernalia, as well as initiations for each of its several degrees of membership. The purpose of the initiation into this society was to strengthen the novices with supernatural power. The Iroquois had a number of secret societies, each with its own officers, ceremonies, songs, and medicines. Although all performed rites to propitiate supernatural beings, the chief function of these societies was to cure disease. In the curing ceremonials of the False Face Society, the members wore grotesque masks carved from the trunks of living trees. Other masks, that represent supernaturals who taught the Iroquois the arts of hunting and agriculture, were woven of corn husks.

Of all the North American cultures here considered, those of the eastern United States are the least well known to science, and the most thoroughly destroyed by the White man's civilization. Save in a few instances, the Indians have disappeared or live much altered lives on reservations. Yet the Indians of the northeast especially played a vital role in United States history, and their friendship and support of the British cause were important factors in the ultimate supremacy of the English over the French in North America.

THE NORTHERN AREA

The northern forests, that great evergreen wilderness stretching mile upon mile across the continent to the south of the Arctic tundra, were one of the most sparsely inhabited regions of native North America. It was also an area of simple, undifferentiated culture, where farming was entirely absent and the arts and crafts rudimentary and undeveloped beyond the level of necessity.

Although the economic and material basis of northern forest culture was much the same from interior Alaska to Newfoundland, this vast region may be divided on linguistic grounds into two major sub-areas by a line separating the Yukon and Mackenzie drainages on the one hand from the Hudson Bay-Atlantic drainage on the other. This division corresponds approximately to the boundary between the Athabascan-speaking tribes to the west and the Algonkian groups of the east.

Within so extensive an area, there were, to be sure, some special cultural features that differentiated tribe from tribe. Thus the Carrier and Kaska, living in the head-

waters of the Pacific coast drainage, were influenced by the Northwest Coast peoples; while the Ingalik, Kutchin, Chipewyan, and Naskapi borrowed some elements of culture from the neighboring Eskimo. Similarly, one branch of the Cree nation that lived in prairie country participated in the life of the Plains, while the southern Ojibwa resembled Great Lakes tribes in many ways. In spite of such marginal differences, however, the underlying cultural uniformity of the interior zone—which reflects primitive adaptation to a hostile, unyielding environment—is striking.

Although the forests of interior Canada were well stocked with game, including caribou, moose, elk, deer, musk-ox, and even bison, the density of the game population varied considerably from one region to the next. In the Mackenzie drainage it was abundant, but within the traditional ranges of the Cree, Montagnais, and Naskapi, it was very sparse and scattered. The native hunters also had to reckon with the migratory habits of their quarries, since many animals and birds were available only during certain seasons of the year. Other difficulties were imposed by the harsh climate. Thus a hunter on snowshoes could easily run down a moose floundering in heavy snow, but these animals were difficult to approach in summer. As a consequence, famines were frequent, and some unlucky bands were driven by starvation to cannibalism. Cree mythology abounds in stories of *windigos*, or supernatural man-eating giants, and early explorers reported actual cases of cannibalism as well.

For many tribes, spring was the lean season. Melting snows hindered travel, and the migratory animals and birds had not yet returned. The winter stores had been consumed, and ice covered the streams and lakes. Summer was usually a season of plenty, and by autumn surplus food had been accumulated for winter. Meat, fish, and berries were dried, *pemmican* was prepared as in the Plains, or game killed during late fall was merely allowed to freeze for winter use. These foods were carefully set aside, stored and protected in caches.

The habits of the game and the nature of the environment thus imposed a nomadic existence upon the dwellers of the northern forests. The life of the Naskapi was typical of that of many tribes. Much of their territory was open plateau covered with grasses and lichens, the feeding grounds for herds of barren-ground caribou. These they followed and hunted from mid-summer to early spring, at which time the animals were too thin to be of much food value. The remainder of the year was spent on the coast or in the interior lake region, fishing and hunting small game and fowl. Other economic patterns were dictated by differing local environments. In the well-wooded Montagnais range, moose was the winter staple, while many impoverished Cree bands subsisted almost entirely on rabbits during winter and geese and ducks in spring. The Carrier, located in the headwarters of the Fraser River, took great catches of salmon, which formed their staple food. The Beaver, on the other hand, were hunters *par excellence*, fishing only when driven by necessity, and living almost exclusively on caribou, moose, bison, and other game.

Hunting methods were similar throughout the area. Moose were stalked with bow and arrow or spear, moose calls of rolled birch bark being used to lure the animals within range. Dogs were also used to bring moose, bear, and caribou to bay. Animals that typically travel in herds, like caribou and musk-oxen, were usually surrounded by a group of hunters and driven into a pound or enclosure, where they could be shot with ease. For small game deadfall traps and noose snares were highly developed, especially in the Mackenzie drainage where hunters snared even caribou and moose.

Fish were taken with nets and seines as well as with weirs of elaborate construction. Others, including whitefish, trout, salmon trout, pike, and pickerel, were caught on hook and line, most commonly by trolling from a canoe. Set lines were also used, and fishing through the ice was general in winter. In addition, eels, sturgeon, and salmon were speared and harpooned, often at night with the aid of torches.

Wild vegetable foods were gathered in all parts of the area, although the importance of them in the total diet varied considerably from tribe to tribe. Berries were mashed and stored for winter use, often being pounded together with meat and fat to prepare *pemmican*.

The material culture of the northern forest peoples was greatly influenced by the nature of their economy. Life itself depended upon mobility to follow the game. In a region dotted by innumerable lakes, interconnected by countless streams and waterways, the light, portable bark-covered canoe was invaluable for summer travel. It could be carried across portages by one man alone, and materials for its construction were readily available. The finest canoes, constructed by the Algonkian tribes, had ribs and gunwhales of cedar, covered over with neatly sewed birch bark that was caulked at the seams with pitch. Elm bark was also used on occasion, and spruce bark was more commonly employed by the Athabascan tribes.

Excellent snowshoes of wood with gut webbing and wooden toboggans were equally essential to winter travel and transport. These useful inventions, along with the northern forest *tipi*, the use of birch bark containers, and fitted clothing, are thought to have spread to sub-Arctic America from the similar environmental region of Asia. The Kutchin employed the Eskimo sled in place of the toboggan just as they built bark vessels resembling the Eskimo "woman's boat." Throughout the forest area, pack straps facilitated transportation during both summer and winter.

People constantly on the move must travel light, and cannot, therefore, afford the luxury of numerous possessions. Pottery, being fragile and thus unsuited to use by nomads, was lacking. As a substitute, all forest tribes manufactured dishes, buckets, and other containers of birch, elm, and spruce bark. Those of the Montagnais and Naskapi were handsomely engraved with floral patterns. Spoons, ladles, and other utensils and containers of wood were likewise in general use. Some tribes, like the western Athabascans, made spruce root cooking baskets, while the Ojibwa and other Algonkian peoples just north of the Great Lakes made some splint and wicker basketry.

Model of Ojibwa village showing the many uses made of birch bark.

Although true loom weaving was absent throughout the northern forests, the Kaska and their neghbors, owing to influences from the Northwest Coast, wove some carrying straps and bands of mountain goat hair. Nearly all tribes made woven rabbit skin blankets for cold weather, and some Algonkian groups wove bags, sashes, and pack straps of bast or nettle fiber.

The typical dwelling of the region was the portable *tipi,* covered either with bark or with caribou skins. On the margins of the forest, however, habitations more typical of adjoining areas were also to be found. Thus the Beaver built some semi-subterranean houses and used the brush-covered lean-to during the summer as did the Plateau tribes. They also constructed rectangular, gabled houses of planks and bark, and carved their house posts with family crests in imitation of the more impressive Northwest Coast dwellings. To the north, the Kutchin used the *tipi,* but also built more substantial semi-subterranean log houses with roof-hatch entrances. Along the southern margin of the area the Ojibwa and some Cree lived in dome-shaped, bark-covered *wigwams,* like the houses of the northeastern tribes, although they used the *tipi* as well.

Clothing was much the same for both sexes. For men it consisted of a long shirt, breech clout, leggings, and moccasins, all of dressed caribou or moose skin. Mittens, a fur robe, and a fur cap might be added during cold weather. Women wore dresses which were similar to the men's shirts, but longer; leggings and moccasins, also of skin, completed the feminine costume, although women also wore robes, mittens, and fur caps during winter. Both the men's shirts and the women's dresses were occasionally made with detachable sleeves. While some groups went around lightly clad during summer, others wore the complete costume the year round as protection against mosquitoes and black flies.

The garments of the forest Indians were ornamented with quill-work, moose-hair embroidery, or painted decoration. The Naskapi early adopted long jackets with hoods cut after archaic French models, and adorned with designs painted in red. Those bands bordering Eskimo territory also adopted fur trousers, boots, or other details of Eskimo clothing.

Like many hunting peoples the world over who have been forced by their subsistence patterns to follow a nomadic mode of life, the social and political organization of the forest Indians was of the simplest. Each tribal group roamed a huge range, but there was no tribal organization whatever. The largest clearly defined political unit was the band, which occupied and controlled a fixed territory with boundaries recognized by its members and their immediate neighbors. The band in turn was composed of a number of families that were usually interrelated by blood.

Yet the scarcity of game necessitated frequent dispersal of the families within a band, so that most wandered the forests in groups of from one to four family units. For most of the year these small groups lived miles apart, uniting but occasionally at some favored hunting or fishing ground. These infrequent reunions were times for feasting and trading, and for the exchange of news.

Within most bands descent was reckoned through both the mother and the father, although the male line received greater emphasis because of the importance of the man as a provider, and because a wife usually joined the band of her husband. It goes without saying that there was no tribal chief; even within the band leadership was highly informal. To be a leader, a man needed courage and the ability to persuade others, but in the last analysis, the hungry nomads followed the most able hunter.

Although this simple, democratic social organization prevailed throughout most of the forest region, some Athabascan tribes, influenced by the rank-conscious Northwest Coast peoples, possessed more elaborate social institutions. Thus Kutchin and Carrier society was class structured, and the members of these tribes were also organized into clans tracing descent through the female line. Kaska tribesmen were divided into two divisions named Wolf and Raven, likewise tracing descent through the mother. These and other western Athabscan groups held *potlatches* for prestige, and placed emphasis upon rank and wealth. To the north of the Great Lakes, the Ojibwa and some Cree had hereditary chiefs and patrilineal clans of the northeastern type; the band, nevertheless, remained the more basic social unit.

Warfare among most forest tribes was conducted only on a small scale. In the main it consisted of blood feuds between bands occasioned primarily by trespass or poaching on the band's territory. The disorganized raids and incursions that followed involved few people, and each warrior acted more or less as a law unto himself. Although women were sometimes taken as wives, and although enemies were occasionally scalped, prisoners were not ordinarily taken, except by some western Athabascans who kept them as slaves.

Religion was equally simple and undeveloped, ritual and ceremonialism being almost absent. Belief in a vaguely defined sky god prevailed, as well as in numerous nature spirits, monsters, giants, and demons. Nearly all tribes held rites for adolescent girls. At puberty, boys were expected to seek spirit guardians who appeared to them in visions, and gave them charms to assure luck in hunting. In connection with hunting there were many taboos and simple rites to propitiate the spirits of game animals. Considering the great insecurity of life in the northern forests, it is not surprising that most tribes attempted to divine the future in many ways, placing great reliance upon dreams and visions, and interpreting the cracks that appeared on the scorched shoulder-blade of an animal.

The shaman, who was thought to possess an especially powerful guardian spirit, reigned supreme in the matter of disclosing the future. By consulting his personal supernatural, he could also explain the scarcity of game or reveal the cause of disease. In public performances that simultaneously frightened, entertained, and awed his audience, the shaman sang, beat his drum, and performed feats of magic and conjuring. Admired for his powers for good, he was equally feared as a malevolent sorcerer.

As early as the seventeenth century, the demands of the European-introduced fur trade began to bring about marked modifications of native life that gradually spread westward through the forests. Contrary to White influences elsewhere, in the northern region European contact tended to strengthen the native hunting economy, although altering it in important ways. The Indians became economically dependent upon the trading posts. Flour and pork largely replaced game as the staple of diet as the hunters shifted their emphasis from caribou and moose to fur-bearing animals. In exchange for mink, beaver, fox, and other pelts, they received firearms, ammunition, traps, blankets, and metal tools. As a consequence, the native material culture virtually disappeared. The White man's religion accompanied the White man's goods, with the result that most tribes soon became converted Christians, at least superficially. The present day Indians of the northern forest thus represent a curious anomaly of the acculturation process: a primitive hunting people who are, nevertheless, almost wholly dependent upon twentieth century mechanized economy.

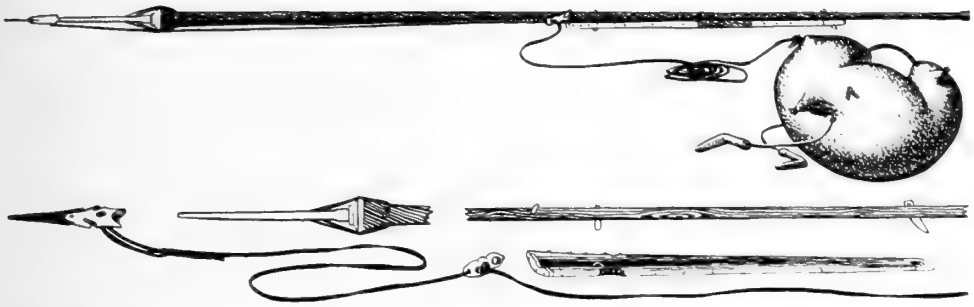
ARCTIC COAST

Like the Northwest Coast, the Eskimo area is one of the most clearly defined in North America. From East Cape in Siberia to Greenland, a distance greater than from New York to San Francisco, the Arctic coast is inhabited by a people who exhibit a unity of racial types, who, excepting the distantly related Aleuts of the Aleutian Islands, speak basically the same language, and who possess a highly original and distinctive culture geared with great ingenuity to life in this area. Occupying the northernmost territory inhabited by any tribes of American aborigines, the Eskimo have had to adapt their mode of living to one of the most extreme environments with which mankind has ever had to contend. It is due, perhaps, to this highly specific adaptation to life in the Arctic that Eskimo culture has remained, until very recently, largely uninfluenced either by the White man or by other North Amerian Indian tribal groups.

Although within Arctic-America temperatures fall well below freezing during mid-winter, the cold is actually less intense here than in the heart of the northern continent. Far more discouraging aspects of Arctic winter are the shortness of the daylight hours, the lack of sunshine, the severity of winter storms, and the great length of the winter season. For some seven months the bays, fiords, and the sea are frozen over. Beneath their icy surfaces, however, the numerous sea mammals, maintaining breathing holes through the ice, offer the hunter rich rewards. Summer, with constant or long hours of sunshine, is by contrast warm and brief. The ice breaks away from the land and forms either drifting pack ice, or else melts completely. These greatly varying conditions have a marked influence on Eskimo life, and fix the pattern of Eskimo culture.

Eskimo economy is geared to the marked variations in the seasons. Winter is the time for hunting marine mammals along the coast, particularly seals and walrus. Other game, hunted especially during the summer months, includes musk-ox, polar bears, and, around Point Hope and elsewhere, whales. Wherever they are found in large numbers, caribou are hunted during summer excursions inland, and some Eskimo groups have come to follow the herds throughout the year. Nearly everywhere the winter food supply is supplemented by fishing through the ice. Fishing is also an important summer activity, especially in the Yukon delta region of Alaska where there are extensive salmon runs, while birds are hunted and their eggs collected wherever suitable rookeries are available.

Above: wooden snow goggles. Eskimo.



East Greenland Eskimo harpoon, showing toggle point, fore shaft, shaft, throwing stick, and seal bladder float.

Hunting techniques, like the game animals, vary according to the seasons. Throughout most of the Arctic zone hunters kill seals during the winter by harpooning the animals at their breathing holes in the ice. In spring, as the ice begins to break up, men imitating the actions of seals stalk the animals over the floating ice and dispatch them with their harpoons, which are often hurled by means of a throwing board. Today the extensive use of rifles threatens many Arctic animals with extermination. During winter the sled, cleverly constructed of bone and wood, and drawn by a team of five or more dogs, figures importantly in hunting and in transporting the game to camp.

When open water returns, seals are hunted from *kayaks,* frame canoes decked over and covered with skins. A second type of boat, the *umiak,* is also made of hides stretched over a wooden frame, but is broader, deeper, and open. It is used primarily for transport, and is propelled by the women except when used for whaling. During the short summer most Eskimo move inland, gathering in bands to hunt caribou. Although individual animals were formerly shot with bow and arrow and are today killed with rifles, the herding habits of the caribou encourage group hunting. The favorite methods of hunting them are to drive the animals into a lake or river where spearmen lie ambushed in *kayaks,* or to pursue them into a narrow valley past lines of hidden hunters.

Greenland Eskimo sled dogs hitched fanwise to single traces.

Eskimo kayak of eastern Greenland.

Marine and land animals furnish the Eskimo with virtually all the necessities of life, since vegetable foods, although gathered when available, contribute little to their diet. Seals, walrus, and caribou supply food, skins for clothing and the linings for houses, as well as bone, ivory, and antler for weapons, tools, and utensils, for except at the deltas of the larger rivers, driftwood is often scarce. In addition, seal blubber is burned in shallow stone lamps with moss wicks to supply light and heat.

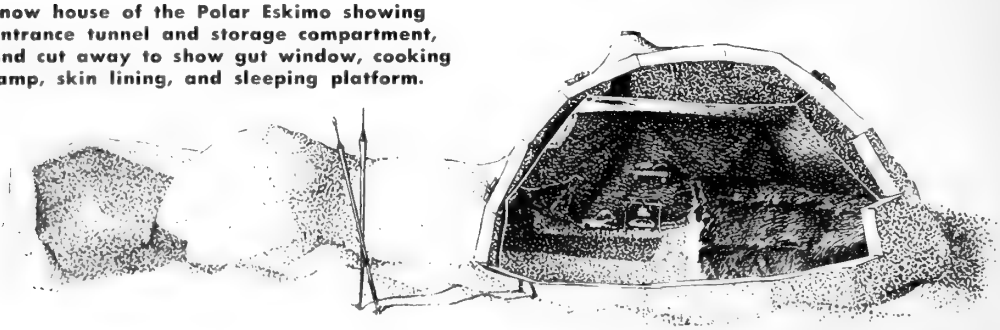
Owing to religious considerations, the products of sea and land animals must be kept strictly apart; caribou may not be hunted during the season for sealing, and caribou meat may not be cooked or eaten in an igloo or on winter ice. The Eskimo eat much of their food raw, or boil it in stone bowls over blubber lamps.

Depending upon geographical location and the season of the year, the Eskimo build several types of houses. The well-known dome-shaped snow house is the permanent winter home of those groups living in the central Arctic region, and is constructed by other Eskimo as a temporary shelter when traveling. Often it is lined with hides for purposes of insulation and is fitted with translucent gut windows for illumination. Elsewhere houses are constructed of whatever material is available. At the eastern extremity of the Eskimo range houses are built along the beaches of rocks and turf, while some of the western Eskimo habitations are made of driftwood. Wherever they are available, whale ribs and jaws are prized as building materials, and most houses have an inner lining of skins and an outer covering of earth or sod. The summer residences of most groups consist of several varieties of hide-covered pole tents.

Eskimo clothing is well adapted to life in the Arctic circle. Men and women alike wear carefully tailored garments of soft tanned skin, usually of caribou or of polar bear in the extreme north. The typical costume for both sexes consists of a shirt worn skin-side out, a long hooded outer jacket worn fur-side out, trousers, boots, and mittens. Waterproof suits of gut are donned as protection against water and damp, and snow goggles of wood or ivory protect the eyes during spring against the incessant glare from snow and ice.

Although in the past some Eskimo made rather inferior pottery, weaving was and is altogether lacking throughout the Arctic. Because of the relative scarcity of wood in most regions, tools and utensils are manufactured of bone, horn, ivory, stone, and even skin. Even at the time of their "discovery" by Whites, some Eskimo were using iron to a limited extent, although they lacked knowledge of mining and smelting. Similarly some groups pounded knives and other articles from nuggets of native copper.

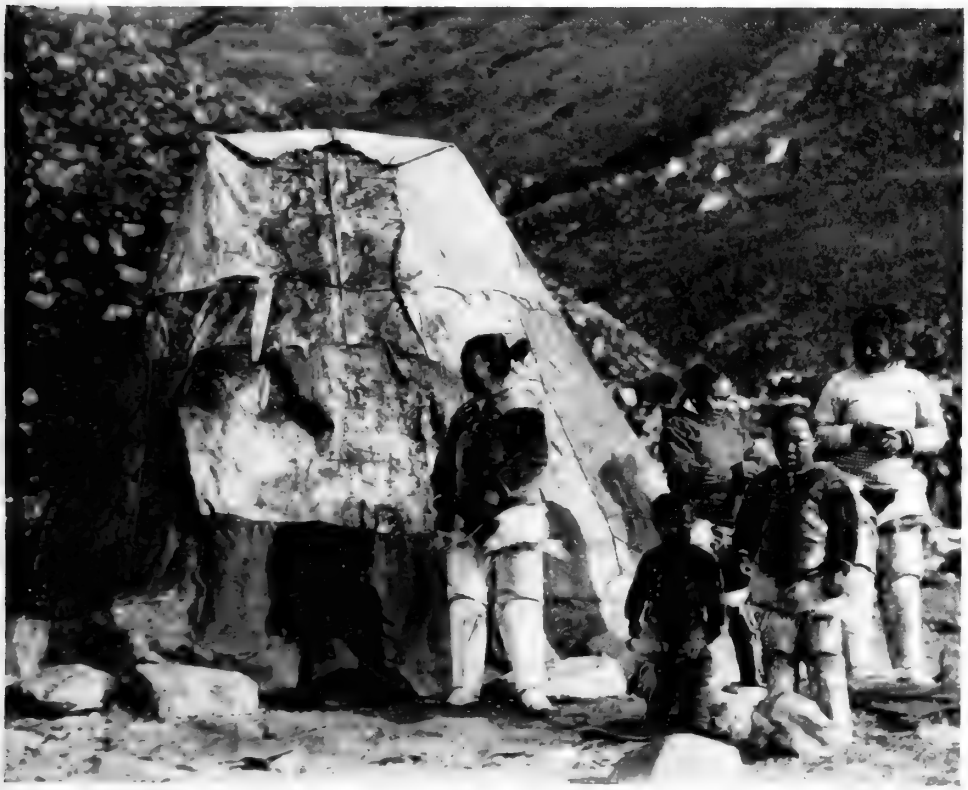
Snow house of the Polar Eskimo showing entrance tunnel and storage compartment, and cut away to show gut window, cooking lamp, skin lining, and sleeping platform.



From these materials the gadget-conscious Eskimo fashion a bewildering number of excellent and ingenious tools and implements, including knives, scrapers, adzes, hammers, drills, awls, hooks, needles and cases, snow beaters, spoons, dippers, combs, back scratchers, goggles, and countless others. The manufacture of these articles is facilitated by the efficiency of the bow-drill which is also employed on occasion to make fire. Eskimo artistic expression is directed chiefly toward the adornment of articles of everyday use, and these are often decorated with incised naturalistic scenes, or engraved with geometric designs.

Although larger communities are encountered in Alaska and in west Greenland, the population of the central Arctic zone is sparse and scattered, most communities being extremely small. Since there is little or no feeling of tribal unity, the basic social unit is the local group composed of several related families who occupy a single coastal settlement and hunt over a traditional territory. Likewise there is no political organization and no chieftainship; the leader in such an activity as a caribou hunt is simply the man who has the greatest skill and experience in this particular undertaking.

Since life in the Arctic makes necessary the close cooperation of group members, the Eskimo have developed somewhat "communistic" attitudes toward food and shelter. The hungry man may help himself from another man's food cache, and an abandoned house may be occupied by anyone. Whatever the Eskimo makes with his own hands, however, is his own private property.



Summer skin tent of the Greenland Eskimo.

Dress of the western Eskimo.

The rigors of life in the Arctic have forced many Eskimo groups at times to infanticide and to disposing of the aged and incapacitated. When a man dies his widow without means of support strangles her small infant. Similarly a widower buries a nursing infant with the dead mother if there is no one else to care for it. Lest the entire community suffer in times of severe famine, old people and cripples are left behind to perish.

Eskimo religion lacks elaborate ritual and ceremonial. There are, however, many folk tales and myths dealing with animals and supernatural beings, and especially with a mythological heroine who is the owner of sea mammals and who, when angered, withholds the supply of seals and walrus. In order to appease this Sea Goddess and other supernatural beings, including ghosts of dead relatives, animal and nature spirits, the Eskimo are obliged to observe numerous taboos and restrictions.

In some areas there is a yearly gathering at which masked men impersonate supernatural beings. It is on these occasions that disputes are settled by means of singing contests during which audience reaction decides the winner and thereby resolves the quarrel.

Although they possess no government and little formal religion, the Eskimo have developed shamanism to a high degree; nearly every family has one shaman, and every village several. In some measure the shaman acts both as a secular and as a religious leader, although he is without formal authority. By means of a familiar spirit, either human or animal, which he may summon to do his bidding, the shaman controls weather, discovers the whereabouts of game, punishes an enemy, or foretells the future. His chief function, however, is to cure disease, the cause of which is usually found to be the violation of a taboo by the patient. The shaman then prescribes the proper offerings to the offended supernatural in order that the patient's health may be restored. While performing, the shaman addresses the spirits in a secret language, beats a tambourine, sings, dances a hysterical dance, and works himself into a state of ecstasy that produces a profound effect upon the audience.

The origins of Eskimo culture are unknown, but archaeologists have traced its development back some two thousand years on the North American continent. Available evidence indicates relationships with the Siberian aborigines of northeastern Asia, and there are in addition suggestions of influences from the earliest dynasties of China.

At the present time there are some 35,000 Eskimo inhabiting the Arctic between Alaska and Greenland. Even though during the past fifty years important changes, particularly in regard to religious beliefs, have been introduced in many regions by whalers, traders, and missionaries, much of the old way of life survives. Indeed, many Eskimo adaptations are so well suited to life in the Arctic that modern civilization can devise no more effective substitutes.

The Aleuts, who, although now nearly extinct, once inhabited the tip of the Alaska peninsula as well as the numerous volcanic islands that stretch for a thousand miles southwestward toward Siberia, were linguistic and cultural relatives of the Eskimo. Their traditional habitat differs considerably from the environment of the Arctic coast. Although gales are frequent and violent, the climate is mild the year round. Fogs, mist, and rain hide the sun almost constantly, but there is little or no snow. As a consequence, there is no sea ice, and the water is open summer and winter. For environmental reasons, Aleut culture differed from that of the Eskimo in many respects. Snow houses and dog sleds, of course, were absent, and ice hunting and fishing could not be practiced. Although the Aleut hunted seals, sea otters, and other marine animals, using Eskimo-like *kayaks* for this purpose, they depended more upon fish—especially salmon, as on the Northwest Coast—as well as upon birds, roots, berries, kelp, and shellfish.

Alaskan Eskimo mask representing a seal spirit.

Since Aleut economy did not depend upon variations in the seasons, permanent villages, each consisting of large communal dwellings housing several families, were occupied. These semi-subterranean habitations, with their earth-covered plank roofs and roof-hatch entrances, resembled those of the Plateau peoples and other tribes of the northern Intermountain area.

Clothing likewise was adapted to the milder Aleutian environment, and was designed to protect the wearer from rain and damp rather than from cold. Both sexes wore long, coat-like tunics of bird skin, sea otter, or sea lion skin over which light, translucent garments of gut served as raincoats. Although boots were used occasionally, men and women alike often went barefoot. Other distinctive Aleut garments included leather trousers for men, and wooden hats with visors and sea lion bristles for decoration.

Aleutian material culture also differed from that of most Eskimo in a number of respects. Fine, flexible baskets were woven, and considerable use was made of wooden utensils and containers, including boxes, bowls, and dishes, as on the Northwest Coast. Other similarities recalling the Northwest Coast were class distinctions, the emphasis on rank, and the practice of keeping slaves. Aleut culture then, before it was destroyed by Russian fur traders, seems to have been a variant of the general Eskimo pattern adapted to a more benevolent climate, but further altered by influences from neighboring culture areas.

NORTH AMERICAN INDIANS TODAY

The present Indian population of the United States, Canada, and Alaska combined is approximately 500,000, or roughly half the estimated population of North America at the time of the discovery of the New World. Disease, warfare, and the destruction of such natural resources as the buffalo herds exterminated and decimated many Indian tribes during the period of White colonization and expansion. A few groups have become so mixed with Whites and Negroes that, were it not for the reservation system that artificially accords them Indian status, they would by now have lost all ethnic identity. Yet although the pure-blood Indian has, paradoxically, become a minority group in a land that was once his by possession, Indians taken as a whole represent at the present time a rapidly increasing population. The most numerous tribes are the Navaho, Sioux, and Cherokee, all of which are larger today than when the White man first invaded their territories.

Similarly, some North American Indian languages are far from extinct. There are at the present time some 60,000 speakers of Navaho, and, so conservative are these people in preserving their native tongue, that traders, teachers, and missionaries are obliged to learn it in order to converse with them. Recently Navaho and Sioux have become written languages, as did Cherokee at an early date.

Today, except in the northern forests and along the Arctic coast, where scattered bands of trappers and hunters continue to roam their traditional homeland, most Indians of North America are residing on reservations, the largest of which are situated in the western half of the continent. In some instances, as in the southwest, these coincide with ancient tribal territories. In others, tribes and remnants of tribes have been collected

on reservations arbitrarily set aside for them, often far removed from their native habitats. Nearly everywhere the ancient way of life is changing, rapidly or slowly, for today the Indian is hemmed in on every side by modern North American civilization. For many adjustment has been painful and difficult. Generally speaking, those tribes that farmed in ancient times have taken more easily to the White man's patterns of land ownership, and to conditions of modern economy and society. Most hunting tribes, once accustomed to roam great territories, have—the northern forest peoples excepted—had greatest difficulty grasping the concept of individual land ownership, and have settled down most reluctantly to a sedentary mode of life. The salmon is still basic in the lives of the Northwest Coast tribes, but today most are employees in salmon canneries.

In spite of conflict and change, however, it seems unlikely that North American Indian culture will disappear entirely, at least not for years to come. Some tribes, like the Navaho and Pueblos, cling tenaciously to much of their traditional way of life. Other groups preserve merely segments of their native cultures. Thus the Western Apache have become successful cattle ranchers, but continue to hold spectaular masked dances for adolescent girls. The Iroquois retain their curing societies and other religious beliefs; many make their living, however, as steel construction workers, tossing white hot rivets high above metropolitan New York as they converse in their native language.

Even the material culture of the Indian has not vanished entirely. Some Pueblo pottery, as well as Navaho blankets and silverware have, if anything, improved over products of the past. Pima and Papago basket making are likewise thriving industries. Other tribesmen have turned their talents in new directions. The Cherokee have recently learned to weave fine hand-loomed fabrics, while the Pueblos, Apache, Navaho, and Kiowa, to name but a few, have produced first-rate painters who today interpret their tribal customs in oils and water colors.

Today the Indians are in large part free to accept or reject what they will of the White man's culture, for it is the policy of an enlightened Bureau of Indian Affairs to give each tribe as free a choice as possible in working out its own destiny. As a consequence, many Indian groups are taking over responsibilities formerly assumed by the federal government. Sympathetic understanding and a tolerance of alien customs and values are required on the part of White Americans, however, if the Indian is to be allowed to take his proper place in the modern world.

BIBLIOGRAPHICAL NOTE

The literature relating to the Indians of North America is very extensive. The reader who desires a more specialized knowledge of the subject is referred to: *Ethnographic Bibliography of North America,* by George Peter Murdock, Yale Anthropological Studies, vol. 1, Yale University Press, New Haven, 1941.

The following series and journals contain numerous monographs and articles:

Bulletins and Annual Reports of the Bureau of American Ethnology, Smithsonian Institution, Washington, D. C.

Bulletins and Reports of the United States National Museum, Washington, D. C.

Anthropological Papers of the American Museum of Natural History. New York.

Anthropological Series of the Chicago Natural History Museum. Chicago.

Papers and Memoirs of the Peabody Museum, Harvard University. Cambridge.

Indian Notes and Monographs, Museum of the American Indian, Heye Foundation. New York.

University of California Publications in American Archaeology and Ethnology. Berkeley and Los Angeles.

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MAN AND NATURE PUBLICATIONS

THE AMERICAN MUSEUM OF NATURAL HISTORY

SCIENCE GUIDE NO. 136

BIRDS OF THE NEW YORK CITY AREA

John L. Bull

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No. 137

THE BIRDS OF THE NEW YORK CITY AREA

A GUIDE TO THE EXHIBIT OF LOCAL BIRDS IN
THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK

BY JOHN L. BULL[1]

[1] *Former President, Linnaean Society of New York.*

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INTRODUCTION

The bird life of the New York City area is both varied and abundant, despite constant growth of the city and its ever-expanding suburbs. For the bird watcher this region is strategically located along the Atlantic Ocean. As here defined, the New York City region includes Long Island, metropolitan New York, and northern New Jersey south to the Manasquan Inlet on the coast and to about Frenchtown on the Delaware. On the west side of the Hudson River, it also includes Rockland County, and that part of Orange County embracing the Palisades Interstate Park system, and thence west to Port Jervis. East of the Hudson, the area includes Westchester and Putnam Counties, and the extreme southwestern portion of Fairfield County in Connecticut east to Wilton, inland, and Westport on Long Island Sound.

This area attracts a large number of nesting and wintering birds, as well as many migrants. The river valleys, mountain ridges, and the long coastline afford favorable migration routes for many species of birds. From the forests, streams, and bogs of the interior, to the pine barrens, salt marshes, and beaches of the coastal areas, many different habitats, or ecological niches, support a varied nesting bird population.

Long Island, jutting into the ocean one hundred and twenty miles, is famous for the variety of oceanic birds and other aquatic and land species, many of which have wandered off their course. Its shoreline, consisting of barrier beaches, bays, inlets, mudflats, salt marshes, and rocky promontories, provides refuge for many northern, southern, and western visitants, as well as the nesting seabird colonies. The mainland, although attracting fewer migrant water birds, supports a greater variety of nesting land birds.

A large area such as this contains an extremely diversified avifauna. From the days of such pioneer ornithologists as Audubon, De Kay and Giraud to the present time, the birdlife of this area has been studied intensively. Nowadays, a great many people observe or band birds for relaxation and recreation. The combined list of species they report annually is impressive, some 300 or more. Another 90 species occur from time to time, either as wind-borne vagrants or accidental wanderers, some of which have been recorded in the New York City region but once or twice. The total number of species reported reliably from the area is about 390. With an additional 30 or more subspecies, the total list of forms seen and collected is approximately 420. The enthusiast, therefore, can find much of interest in the area at any season of the year.

Many changes are continually taking place in the New York metropolitan area. The endless expansion of suburban projects designed for an ever-increasing human population; new industrial and residential construction, often on a vast scale; the elimination of farms and estates for real estate operations; the draining and filling of marshland, both fresh and salt; the cutting and burning of woodland; road building; the development of beaches for summer resorts; widespread spraying with insecticides—all tend to have an unfavorable effect on the native fauna and flora. These changes have undoubtedly reduced the number of nesting birds and, to some extent also, the population of certain wintering birds.

Yet the creation of parks and sanctuaries, both within the city limits and in the surrounding country, has preserved some environment attractive to breeding birds, and has provided resting and feeding grounds for migrants and winter visitants. The New York City area is probably as good now as it ever was for observation of many migrant species. In fact, road construction has proved, in a number of instances, to be a boon for reaching new areas. A network of parkways, bridges and tunnels enables the bird watcher to reach spots that were previously more or less inaccessible.

THE EXHIBIT

The Museum's exhibit of the birds of the New York City area, their nests and eggs, was completed in 1956. It includes all the species, except those that are extinct, such as the Passenger Pigeon, and a few that had once occurred in the area but no longer do, even as stragglers, such as the Wild Turkey. Furthermore, changes are always occurring in the birdlife of an area and since this is so, the following list will include a few rare species not shown in the exhibit.

An innovation in the present exhibit is the use of study skins, specimens prepared for compact storage and for convenient comparison in research. Their use here was partly one of expediency. The Museum has a supply of such specimens, and does not wish to collect more local birds, except in rare instances. Mounted specimens are used here also, and can be made from study skins, but it is increasingly difficult to find taxidermists competent to undertake this task. Actually, study skins lend themselves to modern concepts of design and display, as well as saving valuable space, better than old-fashioned "stuffed" birds. Perhaps, in some instances, they serve as well as mounted birds as aids to field identification, which is the primary aim of this exhibit. A novelty in the nest and egg exhibit is the use of upright cases with mirrors at the top to facilitate viewing the eggs within the nest. The labels state the location of each nest, the number of eggs in a clutch, and the months of the year when the eggs are deposited.

In the following list only the *species* are listed, with very few exceptions. Unless otherwise stated, all species listed have been collected in our area. The scientific and common names used are from the latest (5th) edition of the *A.O.U. Check-List of North American Birds* published in 1957.

The student who wishes to find the more recent books on the birds of the northeast, or on the techniques of studying them, should visit the Museum's bookshop. Among the popular volumes are:

The Field Guides to Eastern and Western Birds by Roger Peterson

The Audubon Bird Guides by Richard Pough, illustrated by Don Eckelberry

Birds Around New York City by Allan D. Cruickshank

A Guide to Bird Watching by Joseph Hickey

LIST OF SPECIES

COMMON LOON *(Gavia immer)*
Common migrant and winter visitant, chiefly along the coast. Regularly flying over inland in May.

ARCTIC LOON *(Gavia arctica)*
Accidental visitant from the north and/or west. One collected specimen in full spring plumage. Sight records of birds in winter plumage are not reliable.

RED-THROATED LOON *(Gavia stellata)*
Common migrant and winter visitant, chiefly on the ocean.

RED-NECKED GREBE *(Podiceps grisegena)*
Uncommon migrant and irregular winter visitant, chiefly along the coast.

HORNED GREBE *(Podiceps auritus)*
Very common migrant and winter visitant, chiefly along the coast.

EARED GREBE *(Podiceps caspicus)*
Very rare or casual coastal visitant from the west, chiefly in winter. One recently collected specimen from the coast of New Jersey proved to be the western race, *californicus*. The species has also been photographed in color.

WESTERN GREBE *(Aechmophorus occidentalis)*
Accidental visitant from the west. Never collected. Two sight records from Long Island are probably correct.

PIED-BILLED GREBE *(Podilymbus podiceps)*
Fairly common migrant. Nesting locally in fresh water marshes. Uncommon in winter on salt water bays.

SOOTY SHEARWATER *(Puffinus griseus)*
Fairly common summer visitant offshore. Usually rare, but regularly seen from the beaches; occasionally in numbers on eastern Long Island.

MANX SHEARWATER *(Puffinus puffinus)*
Accidental visitant from the eastern Atlantic. One Long Island specimen.

AUDUBON'S SHEARWATER *(Puffinus lherminieri)*
Accidental summer visitant from the West Indies. Recorded only from Long Island, at least three specimens collected.

GREATER SHEARWATER *(Puffinus gravis)*
Fairly common summer visitant offshore. Usually rare, but regularly seen from the beaches; occasionally in numbers on eastern Long Island.

panel of nests and eggs

CORY'S SHEARWATER *(Puffinus diomedea)*
The race *borealis* is a common late summer and fall visitant offshore. Less common, but sometimes seen in numbers from the beaches on eastern Long Island. Five specimens of *diomedea*, the more eastern race, from the Mediterranean area, have been taken off the coast of Long Island.

BLACK-CAPPED PETREL *(Pterodroma hasitata)*
Accidental visitant from the West Indies. One old Long Island specimen.

FULMAR *(Fulmarus glacialis)*
Accidental late fall or winter pelagic visitant to the coast, driven in by storms. Four records.

LEACH'S PETREL *(Oceanodroma leucorhoa)*
Very rare or casual visitant to the beaches, in late spring, summer or fall, chiefly after storms.

WILSON'S PETREL *(Oceanites oceanicus)*
Usually common to abundant summer visitant offshore, sometimes entering New York Harbor in large numbers, but rarely seen from the beaches.

WHITE-TAILED TROPIC BIRD *(Phaethon lepturus)*
Accidental visitant from the south after hurricanes. Recorded only from Long Island.

WHITE PELICAN *(Pelecanus erythrorhynchos)*
Accidental visitant from the west. Recorded only from Long Island.

BROWN PELICAN *(Pelecanus occidentalis)*
Accidental visitant from the south, chiefly after storms. Recorded only from the sea coast.

GANNET *(Morus bassanus)*
Common migrant on the ocean; considerably less common in winter.

BROWN BOOBY *(Sula leucogaster)*
Accidental visitant from the south. Recorded only from Long Island, one old specimen, and at least one recent sight record.

GREAT CORMORANT *(Phalacrocorax carbo)*
Uncommon and very local coastal visitant, chiefly in winter. Prefers rocky coasts and breakwaters, where it is regular in small numbers at such places as Montauk, Orient, several points on the Sound shore of Westchester County and Connecticut, and at a few places on the north Jersey coast.

DOUBLE-CRESTED CORMORANT *(Phalacrocorax auritus)*
Very common migrant, rare in winter, and occasional in summer, along the coast. Regularly flying over inland in migration, chiefly in spring.

MAGNIFICENT FRIGATE-BIRD *(Fregata magnificens)*
Accidental summer visitant from the south, after tropical storms. Recorded only from Long Island.

GREAT BLUE HERON *(Ardea herodias)*
Common migrant, uncommon but regular in winter along the coast, and locally in small numbers in summer. Very rarely nesting—one or two small colonies in northern New Jersey, and one large colony found recently on Sandy Hook.

COMMON EGRET *(Casmerodius albus)*
Common summer visitant along the coast. Breeds very locally on Long Island and Sandy Hook.

SNOWY EGRET *(Leucophoyx thula)*
Fairly common, but local summer visitant, chiefly on the south shore of Long Island, where it breeds in several places. Very rare inland. Prior to the mid-1940's, very rare in the region, but in the last ten years much commoner than the Little Blue Heron, at least on the coast of Long Island.

CATTLE EGRET *(Bubulcus ibis)*
Until recent years, primarily an Old World species, thence spreading north from South America. Accidental visitant from the south. Two Long Island records and one from northern New Jersey. Not collected, but photographed in color, and seen by numerous observers.

LOUISIANA HERON *(Hydranassa tricolor)*
Very rare summer visitant on the south shore of Long Island and coastal New Jersey. One pair found nesting in 1955 at the Jamaica Bay Refuge.

LITTLE BLUE HERON *(Florida caerulea)*
Locally common summer visitant, both on the coast and inland. No positive proof of nesting as yet. With a general increase of the white herons in the late 1920's, this species was easily the commonest up to about the mid-1940's, when it became the rarest of the three, which is its status today, at least on the coast of Long Island.

GREEN HERON *(Butorides virescens)*
Common summer resident, widely distributed. In most cases, not a colonial nesting species; usually found in small scattered groups.

BLACK-CROWNED NIGHT HERON *(Nycticorax nycticorax)*
Common permanent resident near the coast, but uncommon in winter. Breeding locally in colonies, chiefly on Long Island.

YELLOW-CROWNED NIGHT HERON *(Nyctanassa violacea)*
Rare and local summer resident, nesting chiefly on Long Island. One large colony on the south shore in 1956 and 1957.

AMERICAN BITTERN *(Botaurus lentiginosus)*
Locally common summer resident, nesting chiefly in fresh water marshes. Decidedly uncommon in winter along the coast.

LEAST BITTERN *(Ixobrychus exilis)*
Uncommon to rare, local summer resident, nesting in fresh water marshes.

WOOD IBIS *(Mycteria americana)*
Accidental visitant from the south. Two Long Island records.

GLOSSY IBIS *(Plegadis falcinellus)*
Very rare spring, summer, or fall visitant from the south.

WHITE IBIS *(Eudocimus albus)*
Accidental visitant from the south. Two old Long Island specimens.

MUTE SWAN *(Cygnus olor)*
Introduced from the Old World. Common permanent resident on the south shore of Long Island, principally at the east end. Relatively uncommon elsewhere.

WHISTLING SWAN *(Olor columbianus)*
Rare, but regular migrant and winter visitant, chiefly on the south shore of Long Island.

CANADA GOOSE *(Branta canadensis)*
Semi-domesticated birds are permanent residents, chiefly on Long Island. Wild birds are common migrants along the coast, less common in winter. Regular on migration inland, rarely alighting.

BRANT *(Branta bernicla)*
Common to abundant migrant and winter visitant on the bays of the south shore of Long Island. Rare to uncommon elsewhere.

BLACK BRANT *(Branta nigricans)*
Accidental visitant from the north and/or west. Recorded only from Long Island.

BARNACLE GOOSE *(Branta leucopsis)*
Accidental visitant from Europe. Recorded only from Long Island.

WHITE-FRONTED GOOSE *(Anser albifrons)*
Accidental visitant to Long Island, either from Greenland or Europe. One recent record.

SNOW GOOSE *(Chen hyperborea)*
The larger eastern race *atlantica,* is a regular and sometimes fairly common late fall and early spring migrant on the coast. Occasionally, large flocks fly over but rarely alight. Rare elsewhere. At least four specimens of the smaller western race, *hyperborea,* have been collected, three from Long Island, and one from New Jersey.

BLUE GOOSE *(Chen caerulescens)*
Rare, but regular migrant along the coast, generally associating with Snow Geese.

MALLARD *(Anas platyrhynchos)*
Semi-domesticated birds are permanent residents throughout. Wild birds are common migrants, less common in winter.

Diving Ducks

BLACK DUCK *(Anas rubripes)*
Abundant migrant, common in winter, and fairly common summer resident.

GADWALL *(Anas strepera)*
Uncommon, but regular migrant and winter visitant on Long Island. Rare elsewhere. Breeds at Tobay Pond, Jones Beach.

PINTAIL *(Anas acuta)*
Very common migrant in New Jersey, less so on Long Island. Uncommon in winter.

EUROPEAN TEAL *(Anas crecca)*[1]
In the 1930's and 1940's, as many as 5 or 6 drakes at one time could be seen on Hempstead Lake, or near-by ponds on western Long Island. Usually found associating with Green-winged Teal. Now a very rare and local winter visitant to Long Island, and purely casual elsewhere.

GREEN-WINGED TEAL *(Anas carolinensis)*
Common migrant and winter visitant on Long Island, less common in New Jersey, and rare elsewhere.

BLUE-WINGED TEAL *(Anas discors)*
Common fall migrant on Long Island and in New Jersey, much less common spring migrant. Nests very locally on Long Island and New Jersey.

SHOVELER *(Spatula clypeata)*
Uncommon, but regular migrant and winter visitant on Long Island, rare elsewhere. Has bred at the new Jamaica Bay Refuge.

EUROPEAN WIDGEON *(Mareca penelope)*
Rare, but regular migrant and winter visitant on Long Island. Very local elsewhere, but has increased recently on the coastal ponds of New Jersey.

AMERICAN WIDGEON OR BALDPATE *(Mareca americana)*
Common migrant and winter visitant on Long Island, less common in New Jersey, and uncommon to rare elsewhere.

WOOD DUCK *(Aix sponsa)*
Local summer resident, nesting in hollow trees usually in or near swampy woods, and sometimes in bird boxes. Rare in winter.

REDHEAD *(Aythya americana)*
Generally rare, but regular migrant and winter visitant on Long Island, but not uncommon locally in the extreme eastern portion. Relatively rare and irregular elsewhere.

RING-NECKED DUCK *(Aythya collaris)*
Locally common migrant and winter visitant on the reservoirs and larger lakes, particularly in Westchester County.

1 *Common Teal in A.O.U. Check-List. A completely misleading name.*

CANVASBACK *(Aythya valisineria)*
Very common winter visitant on the bays of Bronx and Queens Counties, and fairly common on the Hudson River at Croton Point, also Raritan Bay, New Jersey. Relatively uncommon and irregular elsewhere.

GREATER SCAUP *(Aythya marila)*
Abundant winter visitant, particularly in the Pelham Bay area and very common on Long Island Sound and other bays throughout the area.

LESSER SCAUP *(Aythya affinis)*
Fairly common migrant, especially on fresh water. Relatively rare in winter.

COMMON GOLDENEYE *(Bucephala clangula)*
Very common winter visitant, chiefly on Long Island Sound.

BARROW'S GOLDENEYE *(Bucephala islandica)*
Casual winter visitant to Orient and Montauk Points, Long Island. Practically unknown elsewhere.

BUFFLEHEAD *(Bucephala albeola)*
Locally common winter visitant on the inland reservoirs and the bays of Long Island, and New Jersey.

OLDSQUAW *(Clangula hyemalis)*
Very common winter visitant on eastern Long Island Sound and around Montauk Point. Less common elsewhere on the coast.

HARLEQUIN DUCK *(Histrionicus histrionicus)*
Rare, but regular winter visitant at Montauk and Orient Points, and usually in severe winters along the rock jetties on the south shore of western Long Island. Very rare on the Jersey coast.

COMMON EIDER *(Somateria mollissima)*
Rare, but regular winter visitant in the Montauk area, sometimes in small flocks. Very rare elsewhere.

KING EIDER *(Somateria spectabilis)*
Rare, but regular winter visitant in the Montauk area, sometimes in small flocks. Generally very rare elsewhere, but less rare than the preceding species.

WHITE-WINGED SCOTER *(Melanitta deglandi)*
Abundant migrant and winter visitant on the ocean and Long Island Sound.

SURF SCOTER *(Melanitta perspicillata)*
Very common migrant and winter visitant on the ocean and Long Island Sound, particularly at the eastern end.

BLACK SCOTER *(Oidemia nigra)*[1]
Common migrant and winter visitant on the ocean and Long Island Sound.

[1] *Common Scoter in A.O.U. Check-List. The least common of the three species over most of its American range.*

RUDDY DUCK *(Oxyura jamaicensis)*
Uncommon spring and fairly common fall migrant on fresh water, chiefly on eastern Long Island. Regular in small numbers in winter near the coast. Relatively rare in summer, and recently found nesting at the Jamaica Bay Refuge.

HOODED MERGANSER *(Lophodytes cucullatus)*
Common migrant and winter visitant on the lakes and reservoirs of Westchester County, less common on Long Island and New Jersey.

COMMON MERGANSER *(Mergus merganser)*
Abundant winter visitant on the Hudson River, mostly near Croton Point, particularly during severe weather. Otherwise common on the inland reservoirs and lakes. Least common on Long Island. Primarily a fresh water species.

RED-BREASTED MERGANSER *(Mergus serrator)*
Very common to abundant migrant and winter visitant on the Sound, bays, and inlets, and less so on the ocean. Nests rarely on the south shore of Long Island.

TURKEY VULTURE *(Cathartes aura)*
Breeding locally in hilly regions throughout, nesting on the ground, at the base of hollow trees, and in caves. Common migrant in New Jersey. Rare any time on Long Island.

BLACK VULTURE *(Coragyps atratus)*
Very rare or casual visitant from the south.

SWALLOW-TAILED KITE *(Elanoides forficatus)*
Casual visitant from the south.

GOSHAWK *(Accipiter gentilis)*
Generally an irregular winter visitant, occasionally in numbers during flight years, but regular fall migrant (a few) on the mountain ridges.

SHARP-SHINNED HAWK *(Accipiter striatus)*
Very common fall migrant, less so in spring. Rare in winter, and local summer resident, chiefly in the wilder sections, preferring to nest in coniferous trees.

COOPER'S HAWK *(Accipiter cooperii)*
Common fall, uncommon spring migrant, usually uncommon in winter. Fairly common summer resident throughout, preferring deciduous woods.

RED-TAILED HAWK *(Buteo jamaicensis)*
Fairly common migrant in the hilly areas, occasionally in numbers in late fall. In winter common only around Pelham Bay. Nests locally in the mountains of northern New Jersey, in the pine barrens of eastern Long Island, and rarely in hilly country elsewhere.

RED-SHOULDERED HAWK *(Buteo lineatus)*
Fairly common permanent resident in the low alluvial woodlands, except on Long Island, where it is always rare. Common fall migrant inland.

BROAD-WINGED HAWK *(Buteo platypterus)*
Abundant migrant on the ridges. Local summer resident in woodlands, chiefly in the hills, also in the pine barrens of eastern Long Island.

SWAINSON'S HAWK *(Buteo swainsoni)*
Accidental visitant from the west. One old specimen from Cornwall, Orange County, and a recent sight record from northern New Jersey.

ROUGH-LEGGED HAWK *(Buteo lagopus)*
Rare and irregular winter visitant on the coastal and tidal river marshes.

GOLDEN EAGLE *(Aquila chrysaetos)*
Rare, but regular fall migrant on the mountain ridges. Casual elsewhere.

BALD EAGLE *(Haliaeetus leucocephalus)*
Common winter visitant only at Croton Point and then chiefly during very cold weather. Regular fall migrant on the ridges. Elsewhere, rare at any time of year. Very rarely nesting in New Jersey.

MARSH HAWK *(Circus cyaneus)*
Common migrant and winter visitant on the salt marshes of southern Long Island and coastal New Jersey, less common in summer. Elsewhere, relatively rare at any time, but regular in migration.

OSPREY *(Pandion haliaetus)*
Common summer resident only on extreme eastern Long Island, nesting in trees, on telephone poles, on buildings, and sometimes on the ground. A fairly common migrant, chiefly near the shore.

CARACARA *(Caracara cheriway)*
Accidental visitant from the south. One recent Long Island sight record by experienced observers. The bird remained for several days.

GYRFALCON *(Falco rusticolus)*
Casual winter visitant from the Arctic to the south shore of Long Island. The white phase is much rarer than the dark phase.

PEREGRINE FALCON OR DUCK HAWK *(Falco peregrinus)*
Fairly common fall migrant along the ocean beaches. Regular each winter, roosting on tall city buildings. Nests very locally on the Palisades and other cliffs, and very rarely on buildings.

PIGEON HAWK *(Falco columbarius)*
Common fall migrant along the outer coast. Uncommon, but regular in spring.

SPARROW HAWK *(Falco sparverius)*
Fairly common permanent resident throughout in open country, nesting

in tree holes, bird boxes, and building crevices. Common fall migrant along the beaches.

RUFFED GROUSE *(Bonasa umbellus)*
Fairly common permanent resident in heavy forest.

BOBWHITE *(Colinus virginianus)*
Local permanent resident in low, open country, preferring fields, bordered with scrub and brushy swamps. Formerly occurring throughout, it is now found chiefly on the coastal plain of Long Island and New Jersey.

RING-NECKED PHEASANT *(Phasianus colchicus)*
Introduced from the Old World. Common permanent resident throughout. Habitat similar to the preceding species.

KING RAIL *(Rallus elegans)*
Rare and local summer resident, nesting in fresh water marshes. Rare in salt marshes in late fall and winter.

CLAPPER RAIL *(Rallus longirostris)*
Very common summer resident in extensive salt marshes, particularly on the south shore of Long Island east to Jones Beach. Regular, but rare in winter.

VIRGINIA RAIL *(Rallus limicola)*
Locally common summer resident in fresh water marshes. Regular fall migrant in salt marshes also. Rare, but regular in winter.

SORA *(Porzana carolina)*
Local summer resident in fresh water marshes, common only in Troy Meadows and near-by marshes. Common fall migrant in salt marshes also. Rare in winter.

YELLOW RAIL *(Coturnicops noveboracensis)*
Rare, but perhaps regular fall migrant along the coast, usually found in grassy areas adjacent to the salt marsh, and rarely in fresh water marshes. Very secretive.

BLACK RAIL *(Laterallus jamaicensis)*
Rare and very local summer resident, nesting in short grassy salt marshes on the south shore of Long Island. Very secretive.

CORN CRAKE *(Crex crex)*
Accidental visitant from Europe. Three old specimens from Long Island.

PURPLE GALLINULE *(Porphyrula martinica)*
Casual summer visitant from the south, chiefly after storms.

COMMON GALLINULE *(Gallinula chloropus)*
Locally a fairly common summer resident in fresh water marshes. Regular and sometimes common fall migrant, particularly near the coast. Very rare in winter.

AMERICAN COOT *(Fulica americana)*
Common migrant, particularly in fall. Regular, and in some numbers, in winter, chiefly near the coast. Rare and local summer resident, nesting in fresh water marshes.

AMERICAN OYSTERCATCHER *(Haematopus palliatus)*
Very rare summer visitant from the south. Recorded only on the south shore of Long Island. However, a nest with eggs was very recently found on Gardiner's Island.

LAPWING *(Vanellus vanellus)*
Accidental late fall visitant from Europe. Recorded only from Long Island.

PIPING PLOVER *(Charadrius melodus)*
Locally common summer resident on the ocean beaches and sand fill of Long Island and New Jersey.

SEMIPALMATED PLOVER *(Charadrius semipalmatus)*
Abundant migrant along the coast.

WILSON'S PLOVER *(Charadrius wilsonia)*
Very rare summer visitant from the south. Recorded only from Long Island.

KILLDEER *(Charadrius vociferus)*
Fairly common summer resident in open country, nesting on waste areas, fill, and golf courses. Common migrant, and regular, but uncommon in winter near the coast.

AMERICAN GOLDEN PLOVER *(Pluvialis dominica)*
Regular and fairly common fall migrant along the coast, particularly on eastern Long Island, and especially after easterly storms. Very rare in spring. Frequents burned-over meadows, golf courses, and plowed fields.

BLACK-BELLIED PLOVER *(Squatarola squatarola)*
Abundant migrant along the coast. Winters rarely, but regularly on the south shore of Long Island.

RUDDY TURNSTONE *(Arenaria interpres)*
Very common migrant on the coast, preferring rocks and gravelly beaches.

AMERICAN WOODCOCK *(Philohela minor)*
Fairly common migrant, particularly in fall. Locally common summer resident, nesting in moist woodland near open areas. Rare in winter near the coast.

COMMON SNIPE *(Capella gallinago)*
Fairly common migrant in meadows and marshes. Rare but regular in winter near the coast. Very rare breeder in northern New Jersey.

LONG-BILLED CURLEW *(Numenius americanus)*
Casual fall migrant on eastern Long Island. No record in over twenty years.

Woodcock, Snipe, Sandpipers

EURASIAN CURLEW *(Numenius arquata)*
Accidental visitant from Europe. One old Long Island specimen.

WHIMBREL *(Numenius phaeopus)*
The Old World race, *phaeopus,* is an accidental visitant from Europe. One Long Island specimen. The race *hudsonicus,* formerly called Hudsonian Curlew, is an uncommon but regular spring, and fairly common fall migrant along the coast, most flocks flying by without stopping.

UPLAND PLOVER *(Bartramia longicauda)*
Now a rare and very local summer resident on Long Island and in New Jersey, nesting on grassy plains and fields. Rare migrant also.

SPOTTED SANDPIPER *(Actitis macularia)*
Fairly common summer resident throughout. Common on migration.

SOLITARY SANDPIPER *(Tringa solitaria)*
Fairly common migrant inland, rare on the coast.

WILLET *(Catoptrophorus semipalmatus)*
The eastern race, *semipalmatus,* is a rare spring migrant on the coast. Fall status little known, but undoubtedly occurs, very few specimens taken at this season. The western race, *inornatus,* is an uncommon, but regular fall migrant on the coast.

GREATER YELLOWLEGS *(Totanus melanoleucus)*
Common migrant, particularly on the coast. Rare, but regular in winter.

LESSER YELLOWLEGS *(Totanus flavipes)*
Very common fall migrant on the coast. Rare, but regular in spring. Very rare in winter.

KNOT *(Calidris canutus)*
Very common migrant on the coast. Very rare in winter.

PURPLE SANDPIPER *(Erolia maritima)*
Common winter visitant on rocky breakwaters, islands, and beaches.

PECTORAL SANDPIPER *(Erolia melanotos)*
Common fall, uncommon but regular spring migrant on the coast. Occasional inland. Frequents grassy pools.

WHITE-RUMPED SANDPIPER *(Erolia fuscicollis)*
Common fall, fairly common spring migrant on the coast.

BAIRD'S SANDPIPER *(Erolia bairdii)*
Rare, but regular fall migrant on the coast, preferring wet grassy areas, or mud bordering fresh water.

LEAST SANDPIPER *(Erolia minutilla)*
Common spring, abundant fall migrant on the coast. Much less common, but regular inland.

CURLEW SANDPIPER *(Erolia ferruginea)*
Very rare late spring visitant from the Old World, occurring regularly in the Jamaica Bay area. Casual elsewhere.

DUNLIN OR RED-BACKED SANDPIPER *(Erolia alpina)*
Very common coastal migrant. Regular in winter on the coast, occurring locally in numbers.

SHORT-BILLED DOWITCHER *(Limnodromus griseus)*
The nominate race is an abundant migrant on the coast. The inland race *hendersoni,* has been taken on the coast several times.

LONG-BILLED DOWITCHER *(Limnodromus scolopaceus)*
Regular, but uncommon fall migrant on the coast.

STILT SANDPIPER *(Micropalama himantopus)*
Fairly common, but local fall migrant on the coast.

SEMIPALMATED SANDPIPER *(Ereunetes pusillus)*
Abundant migrant on the coast. Uncommon, but regular inland.

WESTERN SANDPIPER *(Ereunetes mauri)*
Common fall, rare spring migrant on the coast.

BUFF-BREASTED SANDPIPER *(Tryngites subruficollis)*
Very rare, but regular fall migrant on the coast, favoring short grassy meadows.

MARBLED GODWIT *(Limosa fedoa)*
Rare, but regular fall migrant on the coast.

BAR-TAILED GODWIT *(Limosa lapponica)*
Accidental visitant from Europe. One recent Long Island specimen.

HUDSONIAN GODWIT *(Limosa haemastica)*
Rare, but regular fall migrant on the coast. Extremely rare in spring.

RUFF *(Philomachus pugnax)*
Very rare visitant from Europe, occurring on the south shore of Long Island in spring, summer and fall. Reported annually in recent years.

SANDERLING *(Crocethia alba)*
Very common migrant on the coast. Less common, but regular in winter. Recorded every month of the year. Prefers the outer beaches.

AMERICAN AVOCET *(Recurvirostra americana)*
Casual fall visitant on the coast.

BLACK-NECKED STILT *(Himantopus mexicanus)*
Accidental visitant from the south. Recorded only from Long Island.

RED PHALAROPE *(Phalaropus fulicarius)*
Regular pelagic spring and fall migrant, coming into shore usually after storms or prolonged periods of fog. Occasionally in large numbers.

NORTHERN PHALAROPE *(Lobipes lobatus)*
Status similar to the preceding species, but occurring much more frequently on shore.

WILSON'S PHALAROPE *(Steganopus tricolor)*
Rare, but regular fall migrant on the coast. Very rare in spring.

POMARINE JAEGER *(Stercorarius pomarinus)*
Uncommon, but regular pelagic fall migrant. Occasional in summer, in numbers, well offshore. Usually rare inshore.

PARASITIC JAEGER *(Stercorarius parasiticus)*
Status similar to the preceding species, but commoner, and perhaps more regular inshore.

LONG-TAILED JAEGER *(Stercorarius longicaudus)*
Very rare or casual pelagic fall migrant.

SKUA *(Catharacta skua)*
Accidental visitant from the north. Recorded only from Long Island.

GLAUCOUS GULL *(Larus hyperboreus)*
Rare, but regular winter visitant, chiefly near the coast.

ICELAND GULL *(Larus glaucoides)*
Uncommon, but regular winter visitant, chiefly near the coast. Now more common than the preceding species. The race *kumlieni* is a rare winter visitant along the coast. The comparative status of nominate *glaucoides* and *kumlieni* is still little known, the identity of immatures being extremely doubtful.

GREAT BLACK-BACKED GULL *(Larus marinus)*
Very common winter visitant, especially on the coast. Breeds locally on eastern Long Island.

LESSER BLACK-BACKED GULL *(Larus fuscus)*
Very rare, or perhaps casual, winter visitant along the coast; one specimen very recently collected near Rutherford, N. J. Frequents garbage dumps.

HERRING GULL *(Larus argentatus)*
Abundant permanent resident, chiefly near the coast. Least numerous in summer (mostly immatures). Breeds in colonies along the coast, chiefly on Long Island.

RING-BILLED GULL *(Larus delawarensis)*
Very common migrant along the coast, locally common in winter, and present in small numbers in summer.

BLACK-HEADED GULL *(Larus ridibundus)*
Very rare, but regular winter visitant from Europe. Confined almost exclusively to New York Harbor, associating with Bonaparte's Gulls. Never collected, but photographed in color.

LAUGHING GULL *(Larus atricilla)*
Very common migrant and less common in summer on Long Island Sound, the Hudson River, New York Harbor, and the coast of New Jersey. Relatively uncommon on the south shore of Long Island where it formerly nested, but increasing in recent years.

FRANKLIN'S GULL *(Larus pipixcan)*
Accidental visitant from the west. Never collected locally. One or two Long Island sight records of adults by experienced observers and probably correctly identified.

BONAPARTE'S GULL *(Larus philadelphia)*
Very common to abundant migrant in New York Harbor, less common in winter. Elsewhere on the coast irregular, but occasionly common, numbers fluctuating from year to year. Very rarely summers.

LITTLE GULL *(Larus minutus)*
From 1929 to about 1950, a very rare, but regular visitant from Europe to New York Harbor, most frequent in spring, associating with Bonaparte's Gulls. Now reported less frequently. Accidental elsewhere.

IVORY GULL *(Pagophila eburnea)*
Accidental visitant from the Arctic. At least three Long Island records, and one recent record from New Jersey.

BLACK-LEGGED KITTIWAKE *(Rissa tridactyla)*
Very common pelagic migrant and winter visitant well offshore, but rarely in numbers near land, except after easterly storms.

SABINE'S GULL *(Xema sabini)*
Casual early fall visitant to the coast of Long Island, principally after storms. Chiefly pelagic, but status offshore little known.

GULL-BILLED TERN *(Gelochelidon nilotica)*
Very rare summer and fall visitant to the coast of Long Island.

FORSTER'S TERN *(Sterna forsteri)*
Fairly common, but somewhat erratic fall migrant along the coast.

COMMON TERN *(Sterna hirundo)*
Very common migrant along the coast. Locally common summer resident on Long Island, nesting in sand with scattered vegetation.

ARCTIC TERN *(Sterna paradisaea)*
Casual early fall visitant to the coast of Long Island. Keeps well offshore south of Massachusetts.

ROSEATE TERN *(Sterna dougallii)*
Now an uncommon and very local summer resident on Long Island. As a migrant, uncommon in spring, fairly common in fall, chiefly at the east end of the Island, but numbers fluctuate greatly from time to time.

SOOTY TERN *(Sterna fuscata)*
Casual fall visitant from the south, chiefly recorded on Long Island after hurricanes.

BRIDLED TERN *(Sterna anathetus)*
Accidental visitant from the south. One Long Island record, a recently collected specimen.

LEAST TERN *(Sterna albifrons)*
Locally common summer resident on the south shore of Long Island, nesting in bare sand, either on the beaches or dry fill. Common migrant on the outer coast.

ROYAL TERN *(Thalasseus maximus)*
Formerly casual; in recent years a rare, but regular summer visitant to Long Island, most numerous after southerly storms. Least rare in the Moriches and Shinnecock areas.

SANDWICH OR CABOT'S TERN *(Thalasseus sandvicensis)*
Accidental visitant from the south. One very recently collected specimen from Mecox Bay, Long Island.

CASPIAN TERN *(Hydroprogne caspia)*
Uncommon to rare, but regular fall migrant on the coast. Very rare in spring.

BLACK TERN *(Chlidonias niger)*
Rare, but regular spring migrant on the coast, occurring in summer. Very common fall migrant along the coast. Rare and irregular inland.

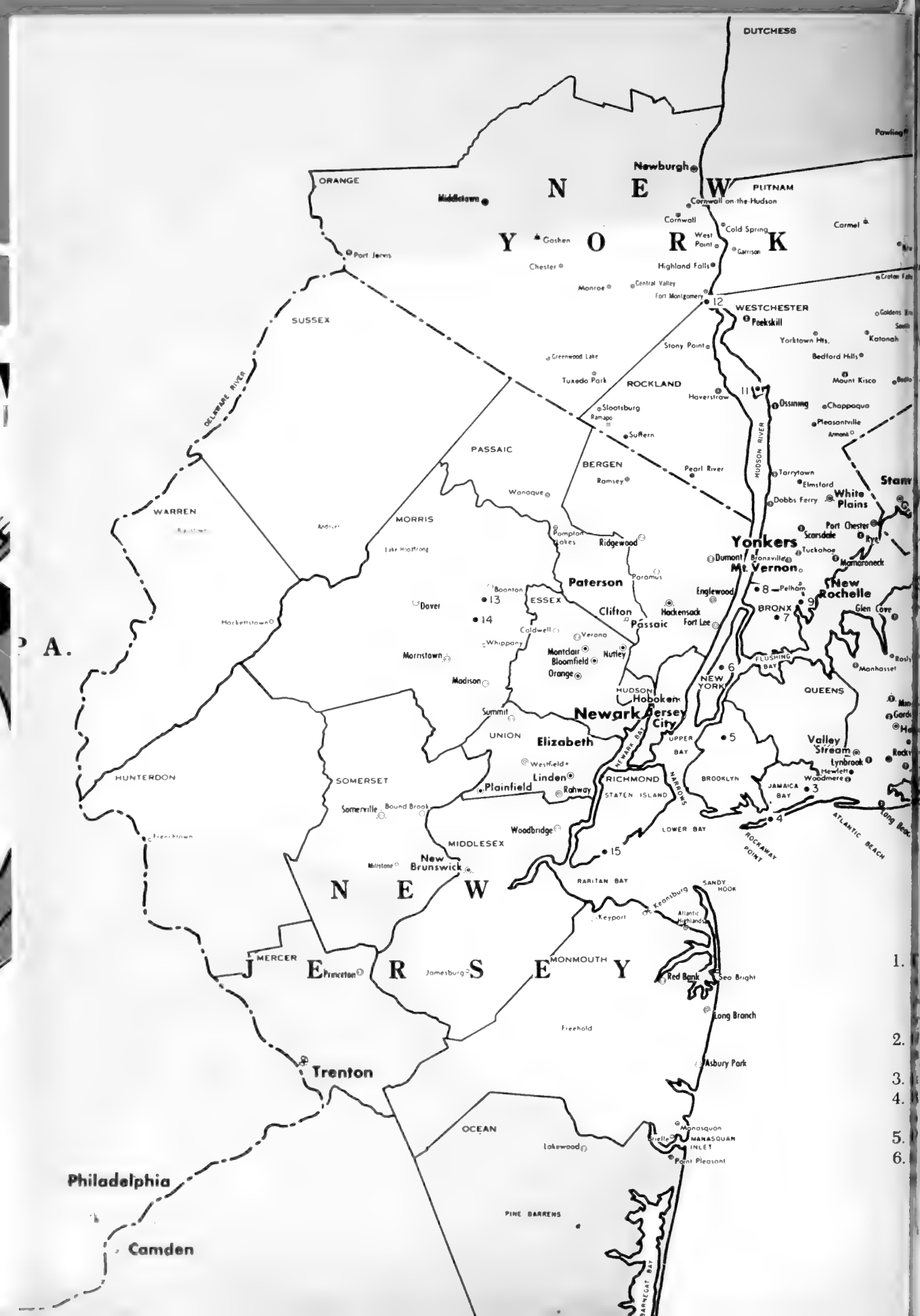
BLACK SKIMMER *(Rynchops nigra)*
Locally common summer resident on the south shore of Long Island, nesting in sand with scattered vegetation. In hurricane years, lingering in numbers to late fall and rarely to early winter.

RAZORBILL *(Alca torda)*
Rare and irregular winter visitant on the outer coast, but always least rare at Montauk Point. Perhaps regular every winter offshore.

COMMON MURRE *(Uria aalge)*
Casual winter visitant from the north. At least five Long Island records, and one for New Jersey. The vernacular name "Common" is somewhat misleading in this area.

THICK-BILLED MURRE *(Uria lomvia)*
Rare and irregular winter visitant along the coast. Perhaps regular and less rare offshore.

DOVEKIE *(Plautus alle)*
Rare, but regular winter visitant on the coast. Sometimes occurs in very large numbers after prolonged easterly gales. Chiefly pelagic.


DUTCHESS
Newburgh
ORANGE
N E W
PUTNAM
Middletown
Cornwall on-the-Hudson
Cornwall
Cold Spring
West Point
Carmel
Y O R K
Port Jervis
Goshen
Chester
Highland Falls
Garrison
Monroe
Central Valley
Fort Montgomery
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WESTCHESTER
Peekskill
SUSSEX
Yorktown Hts.
Katonah
Stony Point
Greenwood Lake
Bedford Hills
Tuxedo Park
ROCKLAND
Mount Kisco
Haverstraw
11
Ossining
Chappaqua
Sloatsburg
Ramapo
Pleasantville
Suffern
DELAWARE RIVER
PASSAIC
HUDSON RIVER
BERGEN
Pearl River
Tarrytown
Wanaque
Elmsford
White Plains
Dobbs Ferry
WARREN
MORRIS
Pompton Lakes
Ridgewood
Port Chester
Scarsdale
Rye
Yonkers
Lake Hopatcong
Tuckahoe
Dumont
Bronxville
Mamaroneck
Mt. Vernon
Paterson
Paramus
Englewood
8
Pelham
New Rochelle
Boonton
13
ESSEX
Dover
BRONX
9
Glen Cove
Clifton
Hackensack
Fort Lee
14
Passaic
Caldwell
Verona
Whippany
Montclair
Bloomfield
Nutley
Morristown
Orange
FLUSHING BAY
6
Manhasset
Madison
HUDSON
NEW YORK
Hoboken
QUEENS
Summit
Newark
Jersey City
UNION
Elizabeth
UPPER BAY
5
Valley Stream
Westfield
Linden
Lynbrook
Hewlett
Woodmere
HUNTERDON
SOMERSET
Plainfield
Rahway
RICHMOND
STATEN ISLAND
NARROWS
BROOKLYN
JAMAICA BAY
3
Somerville
Bound Brook
4
ATLANTIC BEACH
Woodbridge
LOWER BAY
ROCKAWAY POINT
MIDDLESEX
15
New Brunswick
RARITAN BAY
SANDY HOOK
N E W
Keansburg
Keyport
Atlantic Highlands
MERCER
MONMOUTH
J E R S E Y
Princeton
Jamesburg
Red Bank
Sea Bright
Long Branch
Freehold
Trenton
Asbury Park
OCEAN
Manasquan
Brielle
MANASQUAN INLET
Lakewood
Point Pleasant
Philadelphia
PINE BARRENS
Camden
BARNEGAT BAY
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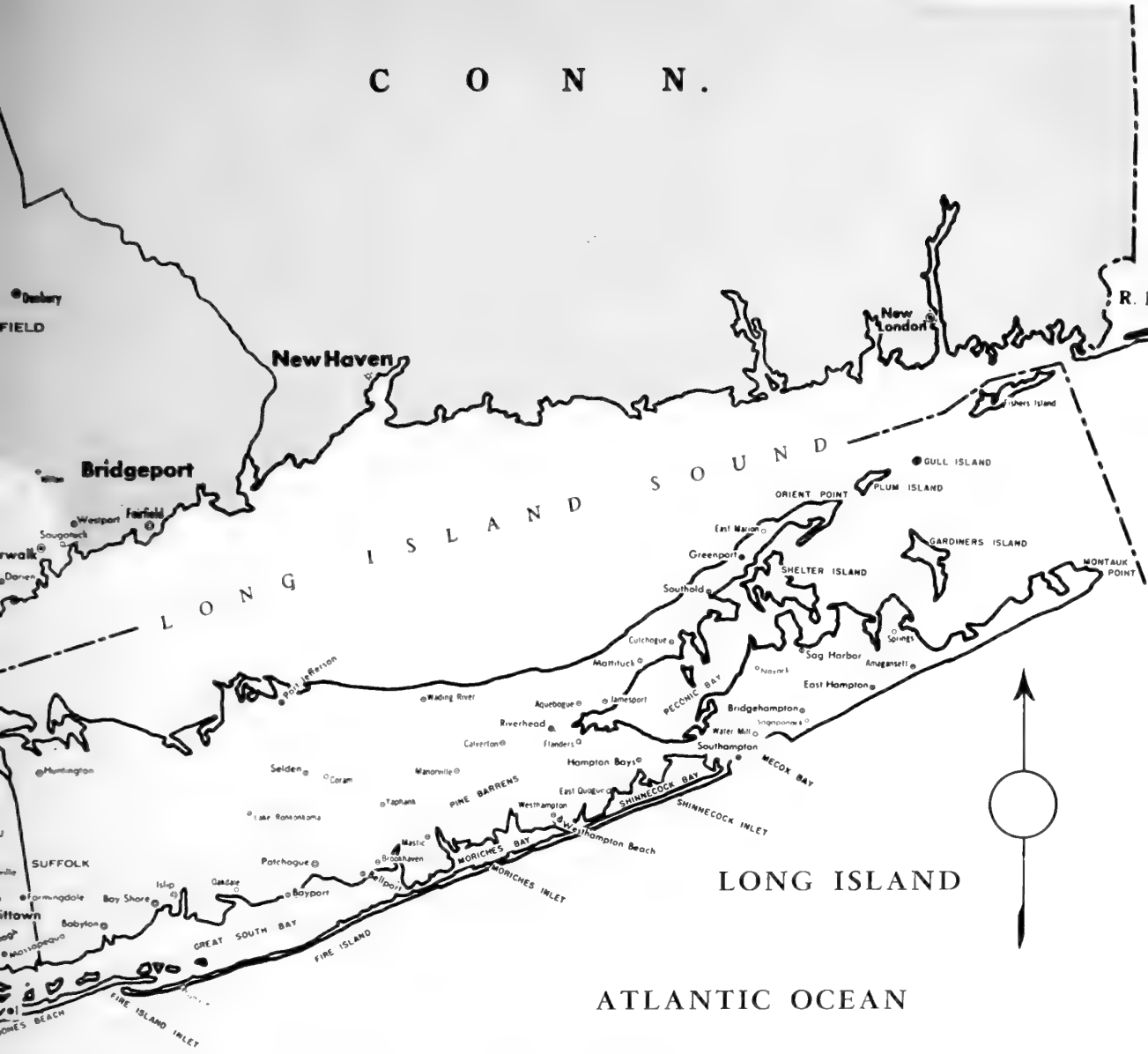


POINTS OF INTEREST

All within 50 miles of New York City

Pond Sanctuary—waterfowl, herons, shore-
in periods of low-water), sea birds (off ocean
, and nesting terns and Black Skimmers (near-

tead Reservoir (and nearby ponds)—water-

a Bay Sanctuary—waterfowl, rails, shorebirds.
rk—migrant land birds, sea birds (off ocean
.
ct Park—migrant land birds.
l Park—migrant land birds, "white-winged"
on reservoir).

7. Bronx Park—migrant land birds, owls, winter finches.
8. Van Cortlandt Park—marsh birds, migrant hawks (ridges).
9. Pelham Bay Park—ducks, owls.
10. Poundridge Reservation—nesting land birds.
11. Croton Point—wintering Bald Eagles, owls.
12. Bear Mountain—migrant hawks, nesting land birds, winter finches.
13. Boonton Reservoir—ducks, nesting land birds (near-by hills).
14. Troy Meadows—migrant and nesting marsh birds.
15. Wolfe's Pond—rare gulls.

In addition, three other areas near New York City are excellent for nesting land birds: Mill Neck Sanctuary on Long Island (near Oyster Bay), Audubon Nature Center in Connecticut (north of Greenwich), and Greenbrook Sanctuary in New Jersey (near Englewood).

BLACK GUILLEMOT *(Cepphus grylle)*
Very rare winter visitant to coastal rocky areas on Long Island, either at the east end, or along the jetties of the south shore.

COMMON PUFFIN *(Fratercula arctica)*
Casual winter visitant at Montauk Point. Very few records elsewhere.

ROCK DOVE *(Columba livia)*
Introduced from the Old World. Common permanent resident throughout.

MOURNING DOVE *(Zenaidura macroura)*
Common summer resident, especially in open country. Regular in winter, chiefly on the coastal plain.

WHITE-WINGED DOVE *(Zenaida asiatica)*
Accidental visitant from the West Indies. One Long Island specimen.

YELLOW-BILLED CUCKOO *(Coccyzus americanus)*
Fairly common summer resident. As a migrant, irregular, rare some years.

BLACK-BILLED CUCKOO *(Coccyzus erythropthalmus)*
Fairly common summer resident. As a migrant, irregular, rare some years.

BARN OWL *(Tyto alba)*
Uncommon, local permanent resident, nesting in old buildings, steeples, and more rarely in hollow trees.

SCREECH OWL *(Otus asio)*
Fairly common permanent resident, nesting in hollow trees, and occasionally in bird boxes.

GREAT HORNED OWL *(Bubo virginianus)*
Locally, a fairly common permanent resident in deep forest, breeding in old deserted nests of crows, hawks or squirrels, also hollow trees, and rarely on cliffs and in caves. One specimen of *wapacuthu*, the Arctic race, an accidental visitant from the north, was taken in Bronx Park.

SNOWY OWL *(Nyctea scandiaca)*
Rare, irregular winter visitant to the shores of the sea coast, at intervals appearing in numbers. Also frequents rat-infested garbage dumps.

HAWK OWL *(Surnia ulula)*
Accidental winter visitant from the north. Three specimens secured locally.

BURROWING OWL *(Speotyto cunicularia)*
Accidental visitant from the west. One eastern Long Island specimen, recently collected.

BARRED OWL *(Strix varia)*
Fairly common permanent resident in low woods and deeply wooded swamps, but not on Long Island, where it is very rare at any time. Breeds in old deserted nests and in hollow trees.

GREAT GRAY OWL *(Strix nebulosa)*
Accidental winter visitant from the north. One Long Island specimen.

LONG-EARED OWL *(Asio otus)*
Locally common winter visitant, sometimes in numbers, in conifer groves. Rare and local breeder, but perhaps overlooked.

SHORT-EARED OWL *(Asio flammeus)*
Found chiefly in salt marshes along the coast, where it is an uncommon migrant. Local, but sometimes reported in numbers in winter, especially on fill and near garbage dumps. Now rare and local summer resident, nesting on the ground. Greatly decreased in recent years.

BOREAL OWL *(Aegolius funereus)*
Accidental winter visitant from the north, but never collected. One or two sight records, possibly correct.

SAW-WHET OWL *(Aegolius acadicus)*
Uncommon to rare, but regular winter visitant, preferring conifer groves.

CHUCK-WILL'S-WIDOW *(Caprimulgus carolinensis)*
Accidental visitant from the south. Never collected locally, but taken twice in Massachusetts and once in Connecticut. Breeding in lower Cape May County, New Jersey, in recent years. Two recent local records of birds heard in northern New Jersey by single competent observers previously familiar with this species.

WHIP-POOR-WILL *(Caprimulgus vociferus)*
Fairly common summer resident in dry woodland in the wilder areas.

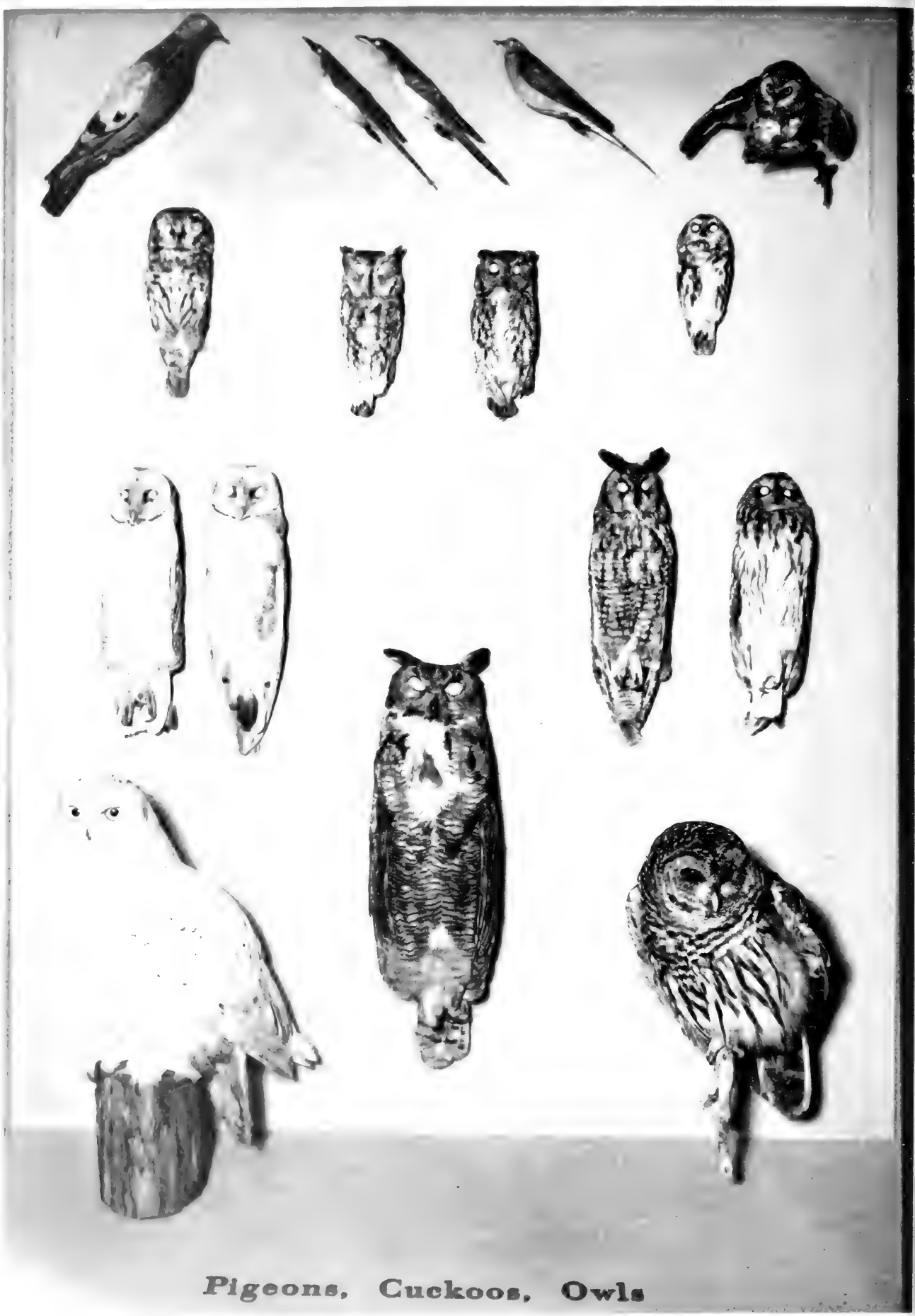
COMMON NIGHTHAWK *(Chordeiles minor)*
Common fall migrant, sometimes flying over in large flocks. Now a local summer resident, nesting on flat gravel roof tops in towns and cities, chiefly on the mainland. Very rare ground nester on the coastal plain in pine barrens and sterile fields.

CHIMNEY SWIFT *(Chaetura pelagica)*
Common summer resident throughout, nesting in unused chimneys. Very common migrant, chiefly in fall.

RUBY-THROATED HUMMINGBIRD *(Archilochus colubris)*
Fairly common summer resident, chiefly in rural areas. Recorded annually in fall on the coast, frequenting flower beds.

BELTED KINGFISHER *(Megaceryle alcyon)*
Fairly common summer resident, nesting in banks. Regular in small numbers near the coast in winter.

YELLOW-SHAFTED FLICKER *(Colaptes auratus)*
Common summer resident. Abundant fall migrant on the coast. Rare, but regular in winter.



Pigeons, Cuckoos, Owls

PILEATED WOODPECKER *(Dryocopus pileatus)*
Fairly common, but local permanent resident in the wilder sections of northern New Jersey, and also Rockland, Putnam and Westchester Counties, New York, and Fairfield County, Connecticut. Nests in forest, and more rarely in large trees near habitations.

RED-BELLIED WOODPECKER *(Centurus carolinus)*
Very rare or casual visitant from the south, chiefly reported near the coast.

RED-HEADED WOODPECKER *(Melanerpes erythrocephalus)*
Now a rare and erratic migrant and summer resident. Least rare as a nesting bird in and near the Passaic Valley in New Jersey. Occurs in winter also.

LEWIS' WOODPECKER *(Asyndesmus lewis)*
Accidental visitant from the west. One recent sight record at a feeder near Ossining, color photographed and seen by numerous observers. It remained for several days.

YELLOW-BELLIED SAPSUCKER *(Sphyrapicus varius)*
Uncommon spring, common fall migrant. Very rare in winter.

HAIRY WOODPECKER *(Dendrocopus villosus)*
Fairly common permanent resident in deep woods, except on Long Island where it is uncommon to rare. Occasional late fall flights reach the outer coast.

DOWNY WOODPECKER *(Dendrocopus pubescens)*
Common permanent resident throughout.

BLACK-BACKED THREE-TOED WOODPECKER *(Picoides arcticus)*
Ordinarily, a casual winter visitant from the north. Otherwise, two marked flight periods (1923 to 1927 and 1956-1957).

EASTERN KINGBIRD *(Tyrannus tyrannus)*
Common summer resident in open country, chiefly in rural areas. Very common fall migrant on the coast.

GRAY KINGBIRD *(Tyrannus dominicensis)*
Accidental visitant from the south. Several coastal records.

WESTERN KINGBIRD *(Tyrannus verticalis)*
Rare, but regular fall migrant on the coast, very rare elsewhere.

FORK-TAILED FLYCATCHER *(Muscivora tyrannus)*
Accidental visitant from the tropics. Never collected. At least two sight records from Long Island.

SCISSOR-TAILED FLYCATCHER *(Muscivora forficata)*
Accidental visitant from the southwest. Never collected. At least two sight records.

GREAT CRESTED FLYCATCHER *(Myiarchus crinitus)*
Fairly common summer resident in heavy deciduous woodland, and occasionally in orchards. A hole nesting species.

EASTERN PHOEBE *(Sayornis phoebe)*
Fairly common summer resident in woodland clearings and around rural habitations, nesting in a variety of situations, such as upturned tree roots, under bridges, and on ledges of country houses. Very common migrant, particularly in fall. Very rare in winter.

SAY'S PHOEBE *(Sayornis saya)*
Accidental visitant from the west. Never collected, but one Long Island sight record, made independently by two experienced observers, is probably correct.

YELLOW-BELLIED FLYCATCHER *(Empidonax flaviventris)*
Regular, but uncommon migrant.

ACADIAN FLYCATCHER *(Empidonax virescens)*
Now a very rare spring and summer visitant, except south of the Raritan River, New Jersey, where it is an extremely local summer resident, nesting in moist shady woodland, or in wooded ravines.

TRAILL'S or ALDER FLYCATCHER *(Empidonax traillii)*
Fairly common, but local summer resident, nesting in alder swamps, or extensive swampy thickets. Very rare on Long Island, except, perhaps, as a migrant.

LEAST FLYCATCHER *(Empidonax minimus)*
Common summer resident north of the coastal plain, but rare at this season anywhere on Long Island. Nests in rural areas, preferring shade trees, orchards and woodland edges. Migrant throughout.

EASTERN WOOD PEWEE *(Contopus virens)*
Common summer resident and migrant, nesting in the forest, in open woodland, and in large shade trees in parks and village streets.

OLIVE-SIDED FLYCATCHER *(Nuttallornis borealis)*
Regular, but local and uncommon migrant, preferring the dead, topmost branches of tall trees.

HORNED LARK *(Eremophila alpestris)*
The nominate, northern race, *alpestris,* is a very common migrant and winter visitant on the coast. Rare and local inland. The race *praticola,* the Prairie Horned Lark, is a locally common breeding resident on the coastal plain, particularly the south shore of Long Island, preferring short, grassy fields, golf courses, and filled in areas. Exact winter status unknown but occurs each year. The race, *hoyti,* from the far north, is a winter visitant of little known status. At least ten specimens collected on Long Island at this season. Sight records are not reliable. Some of the reports of winter Prairie Horned Larks may well be this race, especially flocks.

TREE SWALLOW *(Iridoprocne bicolor)*
Very common spring, abundant fall migrant on the coast. Rare and local in winter on the south shore of Long Island and coastal New Jersey, subsisting on bayberries. Uncommon and local summer residents, nesting in tree holes in wooded swamps and in bird boxes.

BANK SWALLOW *(Riparia riparia)*
Locally common, colonial species nesting in sandy banks, appearing and disappearing, as new banks are formed, or old ones deteriorate or are destroyed. Fairly common spring, common fall migrant, especially along the coast.

ROUGH-WINGED SWALLOW *(Stelgidopteryx ruficollis)*
Locally common summer resident, except on the coastal plain where it is always rare. Not colonial, nesting in bridges, culverts, retaining walls and cutbanks.

BARN SWALLOW *(Hirundo rustica)*
Common summer resident, nesting in barns, sheds, and under bridges. Very common to abundant migrant.

CLIFF SWALLOW *(Petrochelidon pyrrhonota)*
Now a rare and very local summer resident, chiefly found in northern New Jersey. Nests under the eaves of unpainted barns. Rare and erratic as a migrant.

PURPLE MARTIN *(Progne subis)*
Uncommon and local summer resident, chiefly on Long Island and New Jersey. Nesting colonially in multi-chambered bird houses and rarely in gourds suspended from poles. Usually rare as a migrant where it does not nest.

BLUE JAY *(Cyanocitta cristata)*
Common permanent resident, but highly migratory, large flocks flying overhead, both spring and fall. Partial to areas with oaks.

BLACK-BILLED MAGPIE *(Pica pica)*
Casual visitant from the west, but occurring from time to time, chiefly on or near the coast, in fall, winter, or spring.

COMMON RAVEN *(Corvus corax)*
Very rare, but perhaps regular fall migrant on the mountain ridges of northwestern New Jersey. Casual elsewhere.

COMMON CROW *(Corvus brachyrhynchos)*
Common permanent resident, but highly migratory, heavy flights occurring regularly in spring and fall, chiefly inland. Locally abundant in winter roosts, but less commonly than in former years.

FISH CROW *(Corvus ossifragus)*
Fairly common summer resident in the vicinity of Long Island Sound, the bays around New York City, and up the larger river valleys, but relatively

rare along the ocean front and bays on the south side of Long Island. Uncommon and local in winter.

BLACK-CAPPED CHICKADEE *(Parus atricapillus)*
Common permanent resident, but most numerous in fall (occasionally very large flights) and winter, and least common in summer. Nests in tree holes and bird boxes.

CAROLINA CHICKADEE *(Parus carolinensis)*
Replaces the preceding species south of the Raritan River generally, but range overlap between the two species apparently occurs in this area. Fairly common permanent resident.

BOREAL CHICKADEE *(Parus hudsonicus)*
Extremely rare and irregular winter visitant occurring singly or in very small flocks. Three principal flight periods (1916-17, 1941-42, and 1954-55).

TUFTED TITMOUSE *(Parus bicolor)*
Common permanent resident in low, rich woodland, west of the Hudson River, except in the mountains. Uncommon and local in Bronx and southern Westchester Counties, but increasing, and apparently, very recently becoming common along the shore in Fairfield County, Connecticut. Purely casual on Long Island. Nests in tree holes.

WHITE-BREASTED NUTHATCH *(Sitta carolinensis)*
Fairly common permanent resident in deciduous woodland, and near habitations, nesting in tree holes and bird boxes. Most numerous in winter.

RED-BREASTED NUTHATCH *(Sitta canadensis)*
Irregular fall migrant and winter visitant, mostly along the coast. Sometimes very common in fall. Found chiefly in pines.

BROWN CREEPER *(Certhia familiaris)*
Common migrant, less common in winter. Rare and local summer resident in wooded swamps, nesting under loose bark.

HOUSE WREN *(Troglodytes aedon)*
Common summer resident, nesting in bird houses and tree cavities.

WINTER WREN *(Troglodytes troglodytes)*
Regular, but uncommon migrant, rarer in winter. Prefers thickets and brush piles.

BEWICK'S WREN *(Thryomanes bewickii)*
Accidental visitant to Central and Prospect Parks. Not collected, but observed by many competent observers. Breeds east to central Pennsylvania.

CAROLINA WREN *(Thryothorus ludovicianus)*
Erratic resident, locally common for a number of years, only to be extirpated by severe winters, and recovering after a succession of mild ones. Commonest in New Jersey, along the Palisades, and on eastern Long Island. Prefers to nest in wooded ravines, dense tangled thickets, hollow tree stumps, and around old sheds in rural areas.

LONG-BILLED MARSH WREN *(Telmatodytes palustris)*
Locally, very common summer resident, nesting chiefly in cattail marshes, but also in *Phragmites* and other dense grasses adjacent to salt marshes. Rare in winter along the coast.

SHORT-BILLED MARSH WREN *(Cistothorus platensis)*
Rare, local summer resident, nesting in damp, grassy meadows inland, and more rarely in short *Spartina* grass on the salt meadows, where it is not too wet. Very rare in winter along the coast.

MOCKINGBIRD *(Mimus polyglottos)*
Rare, erratic visitant, chiefly on the coastal plain. Nests sporadically on Long Island, but fairly regularly though very locally, in New Jersey. Regular fall migrant along the coast, but a possibility at any time of year.

CATBIRD *(Dumetella carolinensis)*
Very common summer resident throughout. Rare, but regular in winter.

BROWN THRASHER *(Toxostoma rufum)*
Common summer resident in dry open country, preferring to nest in thickets. Rarer than the Catbird in winter.

ROBIN *(Turdus migratorius)*
Abundant migrant and summer resident, wintering locally in numbers. The northern black-backed race, *nigrideus,* is, perhaps, a regular migrant and winter visitant. At least five specimens taken locally from November to March are in the American Museum collection.

VARIED THRUSH *(Ixoreus naevius)*
Accidental late fall visitant from the west.

WOOD THRUSH *(Hylocichla mustelina)*
Common summer resident in moist open woodland, and less common in parks and suburban yards if there are numerous shade trees and shrubbery.

HERMIT THRUSH *(Hylocichla guttata)*
Common migrant. Rare, but regular in winter along the coast. Locally common summer resident in the pine barrens of eastern Long Island, but rare in the mountains of northern New Jersey.

SWAINSON'S or OLIVE-BACKED THRUSH *(Hylocichla ustulata)*
Very common migrant, particularly in fall.

GRAY-CHEEKED THRUSH *(Hylocichla minima)*
Fairly common migrant, more numerous in fall. The smaller race *bicknelli,* is a fairly common migrant. Numerous specimens collected and banded.

VEERY *(Hylocichla fuscescens)*
Common summer resident in moist, rich woodland, north of the coastal plain. Very common migrant, and abundant in early fall, passing over at night in large numbers.

EASTERN BLUEBIRD *(Sialia sialis)*
Now an uncommon summer resident in open rural country, nesting in bird boxes and tree holes around farms and orchards. Uncommon spring, common fall migrant. Regular in winter, chiefly inland.

WHEATEAR *(Oenanthe oenanthe)*
Casual or accidental fall visitant from the north. Most of the records are from Long Island.

TOWNSEND'S SOLITAIRE *(Myadestes townsendi)*
Accidental visitant from the west. One Long Island specimen.

BLUE-GRAY GNATCATCHER *(Polioptila caerulea)*
Uncommon, but regular migrant, chiefly in spring. Very rare breeder in New Jersey, but increasing.

GOLDEN-CROWNED KINGLET *(Regulus satrapa)*
Fairly common migrant, uncommon to rare in winter. Frequents evergreens. Subject to marked fluctuations in numbers.

RUBY-CROWNED KINGLET *(Regulus calendula)*
Common migrant. Very rare in winter.

WATER PIPIT *(Anthus spinoletta)*
Uncommon spring, very common fall migrant, found chiefly on or near the coast. Rare and irregular in winter.

BOHEMIAN WAXWING *(Bombycilla garrula)*
Accidental winter visitant from the northwest. Several old specimens. Few authentic reports for more than twenty years.

CEDAR WAXWING *(Bombycilla cedrorum)*
Common summer resident, chiefly inland in rural areas. Uncommon spring, but very common fall migrant. Usually rare and local in winter. However, this species is subject to wide fluctuations, and its appearance throughout the year is erratic and unpredictable, except in August and September, when it is regular.

NORTHERN SHRIKE *(Lanius excubitor)*
Rare and irregular winter visitant, chiefly near the coast. Least rare at Montauk, where seen every winter.

LOGGERHEAD SHRIKE *(Lanius ludovicianus)*
Rare, but regular fall migrant on the coast of Long Island. Very rare in winter, and as a spring migrant.

STARLING *(Sturnus vulgaris)*
Introduced from the Old World. Abundant permanent resident.

WHITE-EYED VIREO *(Vireo griseus)*
Local and uncommon summer resident in lowland areas, nesting in thickets and in brushy edges of swamps.

BELL'S VIREO *(Vireo bellii)*
Accidental visitant, but never collected. Several sight records for Long Island and the city parks, possibly correctly identified.

YELLOW-THROATED VIREO *(Vireo flavifrons)*
Fairly common summer resident north of the coastal plain, but rare on Long Island. Nests in rich open woods, and occasionally in large shade trees along rural village streets.

SOLITARY or BLUE-HEADED VIREO *(Vireo solitarius)*
Fairly common migrant. Rare breeder in the mountains.

RED-EYED VIREO *(Vireo olivaceus)*
Very common migrant and summer resident.

PHILADELPHIA VIREO *(Vireo philadelphicus)*
Very rare spring and rare but regular fall migrant.

WARBLING VIREO *(Vireo gilvus)*
Uncommon and local summer resident, nesting in tall shade trees, preferably elms, in parks, rural villages, and along streams.

BLACK-AND-WHITE WARBLER *(Mniotilta varia)*
Common summer resident in deciduous woodland. Very common migrant.

PROTHONOTARY WARBLER *(Protonotaria citrea)*
Very rare, but regular spring migrant. Several recent nesting records for northern New Jersey. Prefers wooded streams and swamps, even as a migrant. Our only hole nesting warbler.

SWAINSON'S WARBLER *(Limnothlypis swainsonii)*
Accidental visitant from the south. Never collected, and only one recent sight record from Prospect Park, made by a number of competent observers and probably correct.

WORM-EATING WARBLER *(Helmitheros vermivorus)*
Locally common summer resident in hilly woodland north of the coastal plain. Nests in dense undergrowth. Rare at any time on Long Island. Generally an uncommon migrant throughout.

BLUE-WINGED WARBLER *(Vermivora pinus)*
Common summer resident, nesting in the drier portions of scrubby fields, woodland borders, especially second growth, particularly where brier thickets occur. Rare or absent in the mountains.

GOLDEN-WINGED WARBLER *(Vermivora chrysoptera)*
Locally common summer resident in the highlands of New Jersey, and Rockland, Orange, and Putnam Counties, preferring to nest in the same situations as the preceding species. Uncommon to rare as a migrant, where it does not nest, particularly on Long Island.
The form known as Brewster's Warbler, is a rare hybrid of the two preceding species, occurring where they overlap. Least rare in the hills west

of the Hudson River. Rare as a migrant. The form known as Lawrence's Warbler is another product of hybridization, and a much rarer migrant.

TENNESSEE WARBLER *(Vermivora peregrina)*
Uncommon to rare, but regular spring, usually common fall migrant, but numbers fluctuate yearly.

ORANGE-CROWNED WARBLER *(Vermivora celata)*
Rare, but regular fall migrant. Very rare in winter and spring.

NASHVILLE WARBLER *(Vermivora ruficapilla)*
Fairly common migrant. Breeds in the mountains, nesting in woodland clearings, either in moist areas, or in dry open slashings or low second growth.

PARULA WARBLER *(Parula americana)*
Very common migrant. Now very rare and local as a summer resident, nesting either in the bogs of northwestern New Jersey, or in moist woodland, or at the edges of ponds on eastern Long Island. In the latter place it is dependent upon the *Usnea* lichen, which has practically disappeared.

YELLOW WARBLER *(Dendroica petechia)*
Common summer resident, nesting in shrubbery in rural gardens, in bushes at the edges of swamps, lakes and streams, and in bayberry and poison ivy thickets on the coast.

MAGNOLIA WARBLER *(Dendroica magnolia)*
Very common migrant. Rare and local breeder in the mountains of northwestern New Jersey.

CAPE MAY WARBLER *(Dendroica tigrina)*
Fairly common spring, usually common fall migrant, but numbers fluctuate yearly.

BLACK-THROATED BLUE WARBLER *(Dendroica caerulescens)*
Common migrant. Rare and local breeder in the mountains.

MYRTLE WARBLER *(Dendroica coronata)*
Abundant migrant. Common in winter on the coast wherever there are bayberry thickets.

TOWNSEND'S WARBLER *(Dendroica townsendi)*
Accidental visitant from the west. Never collected, but two sight records of Long Island birds made by competent observers are probably correct.

BLACK-THROATED GREEN WARBLER *(Dendroica virens)*
Locally common summer resident, nesting wherever extensive tracts of white pine and hemlock occur. Less common in pitch pines on the coast, and locally in deciduous woods on Long Island. Common migrant.

CERULEAN WARBLER *(Dendroica cerulea)*
Very rare migrant throughout, except on Long Island, where it is casual.

Very rare summer resident in New Jersey, nesting in tall, deciduous trees, usually near streams or rivers.

BLACKBURNIAN WARBLER *(Dendroica fusca)*
Fairly common spring, relatively uncommon fall migrant. Local breeder in the mountains, nesting in stands of conifers.

YELLOW-THROATED WARBLER *(Dendroica dominica)*
Both races, the nominate *dominica* and *albilora,* the Sycamore Warbler, have been collected locally. As a species, a rare but regular late April and early May migrant, chiefly in the city parks. Much rarer in September on the coast. One recent breeding record on the Delaware River.

CHESTNUT-SIDED WARBLER *(Dendroica pensylvanica)*
Common summer resident, nesting in second growth and thickets, but rare on the coastal plain. Very common migrant, especially in spring.

BAY-BREASTED WARBLER *(Dendroica castanea)*
Usually a fairly common migrant, but some years decidedly uncommon. Subject to yearly fluctuations.

BLACKPOLL WARBLER *(Dendroica striata)*
Very common migrant, occasionally abundant in fall.

PINE WARBLER *(Dendroica pinus)*
Common summer resident in mature pine barrens, but not in the scrub or burned over areas. Rare and local inland, wherever pitch pine occurs, and very rarely in mature white pine. As a migrant, erratic, usually uncommon in spring and rare in fall. Very rare in winter.

PRAIRIE WARBLER *(Dendroica discolor)*
Very common summer resident in scrub oak and pine barrens of the coastal plain. Less common inland on dry hillsides or fields with scattered cedars and shrubby thickets. Common migrant, but absent in the mountains.

PALM WARBLER *(Dendroica palmarum)*
The nominate western race is a rare, but regular spring, common fall migrant, particularly on the coast. Rare in winter along the coast. The race *hypochrysea,* the Yellow Palm Warbler, is a common migrant, but subject to marked fluctuations; some years, especially in spring, in small numbers. Rare in winter along the coast.

OVENBIRD *(Seiurus aurocapillus)*
Common summer resident, chiefly in deciduous woodland. Very common migrant.

NORTHERN WATERTHRUSH *(Seiurus noveboracensis)*
Common migrant. Fairly common, but local summer resident in the mountains, nesting in woodland swamps. The western race *notabilis,* has been taken twice in the region, and perhaps occurs rarely in fall, and possibly in late May.

LOUISIANA WATERTHRUSH *(Seiurus motacilla)*
Fairly common summer resident north of the coastal plain, nesting in woodland along streams. Always rare on Long Island, even as a migrant, particularly on the south shore.

KENTUCKY WARBLER *(Oporornis formosus)*
Very rare, extremely local summer resident in Westchester County and New Jersey. Nests in rich, moist woodland, with dense undergrowth, and usually in ravines. Casual migrant and very secretive.

CONNECTICUT WARBLER *(Oporornis agilis)*
Very rare spring, uncommon to rare, but regular fall migrant, formerly less rare. Prefers swampy woodland thickets inland. On the coast it frequents dense tangles of ragweed, sunflower, etc. Very secretive.

MOURNING WARBLER *(Oporornis philadelphia)*
Rare, but regular late spring migrant, chiefly north of the coastal plain, occurring in dense swampy thickets and shrubbery in city parks. Very rare in fall and difficult to observe, probably because of the thick vegetation at this season. Very secretive.

YELLOWTHROAT *(Geothlypis trichas)*
Common summer resident, nesting in wet or dry areas, wherever there are thickets or tangles of bushes. Very common to abundant migrant. Very rare in winter.

YELLOW-BREASTED CHAT *(Icteria virens)*
Fairly common, but somewhat local summer resident, nesting in dense thickets, especially brier, in open country. Usually rare and secretive as a migrant. Very rare in winter.

HOODED WARBLER *(Wilsonia citrina)*
Locally common summer resident north of the coastal plain, but rare on Long Island, even during migration. Nests in the undergrowth of moist, rich woodland, chiefly on hillsides with laurel thickets, and very locally along the coast in New Jersey in cedar swamps near the pine barrens. Generally uncommon as a migrant throughout.

WILSON'S WARBLER *(Wilsonia pusilla)*
Fairly common migrant, especially in spring, and occasionally in numbers. Rarer in fall.

CANADA WARBLER *(Wilsonia canadensis)*
Fairly common summer resident in the highlands of the interior, nesting in moist rich woodland. Common migrant.

AMERICAN REDSTART *(Setophaga ruticilla)*
Very common summer resident, preferably in second growth woodland, but local on the coastal plain. Abundant migrant.

Flycatchers, Larks, Swallows

HOUSE SPARROW *(Passer domesticus)*
Introduced from the Old World. Abundant permanent resident in settled areas.

BOBOLINK *(Dolichonyx oryzivorus)*
Now a very local summer resident throughout, nesting in grassy fields and meadows. As a migrant, usually uncommon to rare, but regular in spring, common, often abundant in fall, particularly as a night migrant. Rarely alights in large flocks, except in favorable places.

EASTERN MEADOWLARK *(Sturnella magna)*
Locally common summer resident, nesting in grassy fields and meadows. Uncommon, but regular in winter on the coast.

WESTERN MEADOWLARK *(Sturnella neglecta)*
Accidental visitant from the west, recorded only from New Jersey. Never collected, but several recent sight records of singing males made by competent observers are possibly correct.

YELLOW-HEADED BLACKBIRD *(Xanthocephalus xanthocephalus)*
Casual fall visitant from the west. Recorded chiefly from Long Island.

RED-WINGED BLACKBIRD *(Agelaius phoeniceus)*
Very common summer resident, nesting in marshes, wet meadows, and occasionally in lush fields. Abundant migrant. Locally common in winter on the coast.

ORCHARD ORIOLE *(Icterus spurius)*
Locally common summer resident in the lowlands of central and western New Jersey, rare and very local elsewhere. Nests in orchards, shade trees in farming country, and to a lesser extent in trees near ponds and streams.

BALTIMORE ORIOLE *(Icterus galbula)*
Common summer resident, preferring to nest in elms, but also occasionally in maples and other trees. Decidedly rare in winter, almost always at feeding stations.

RUSTY BLACKBIRD *(Euphagus carolinus)*
Fairly common migrant, except on Long Island, where uncommon to rare. Most numerous in New Jersey. Found chiefly in wooded swamps. Rare and local in winter.

COMMON GRACKLE *(Quiscalus quiscula)*
The race *stonei*, the Purple Grackle, is a very common summer resident, preferring to nest in tall ornamental conifers, especially spruce, in suburban yards, parks, and golf courses. The race *versicolor*, the Bronzed Grackle, is an abundant migrant, chiefly inland, and in fall. Local, but sometimes common in winter, such as at roosts of mixed blackbirds. Most of the collected winter specimens are of this subspecies.

BROWN-HEADED COWBIRD *(Molothrus ater)*
Common summer resident in more open country. Parasitic, laying its eggs in other birds' nests. Abundant migrant, and uncommon but regular in winter, sometimes in flocks.

WESTERN TANAGER *(Piranga ludoviciana)*
Formerly accidental visitant from the west. Still very rare or casual, but in recent years has appeared in late fall and winter, chiefly in the fruit bearing bushes of parks on the sea coast of western Long Island, and at feeding stations in inland New Jersey. Collected once years ago, and recently photographed in color.

SCARLET TANAGER *(Piranga olivacea)*
Common summer resident in rich woodland, north of the coastal plain, but relatively rare and local on the coastal plain. Prefers to nest in oak woods. Common migrant throughout.

SUMMER TANAGER *(Piranga rubra)*
Very rare, but regular spring migrant, chiefly near the coast. Majority of records are in late April and the first half of May. A few fall records.

CARDINAL *(Richmondena cardinalis)*
Common permanent resident in New Jersey in low rich woodlands and occasionally around houses. Fairly common, but local elsewhere, on the mainland. In recent years, greatly increased, but decidedly uncommon to rare on western Long Island and still very rare at the eastern end.

ROSE-BREASTED GROSBEAK *(Pheucticus ludovicianus)*
Common summer resident in rich woodland, and shade trees in rural areas, north of the coastal plain, but rare on the north shore of Long Island. Common migrant throughout, except over much of the sandy coastal plain.

BLACK-HEADED GROSBEAK *(Pheucticus melanocephalus)*
Accidental visitant from the west. Never collected, but photographed in color at least once. At least five or six recent records in fall, winter, or early spring, chiefly at feeders, including several adult males.

BLUE GROSBEAK *(Guiraca caerulea)*
Casual or very rare spring visitant from the south, chiefly in May. Rare fall migrant on the coast, in recent years recorded nearly every October, identification amply confirmed by competent and experienced observers. Many other records by beginners are misidentified Indigo Buntings.

INDIGO BUNTING *(Passerina cyanea)*
Fairly common summer resident, chiefly inland, around abandoned, overgrown farms, low second growth about clearings and woodland edges, and thickets along country roads. As a migrant, numbers fluctuate, occasionally common, particularly on lawns in city parks, and regular on the coast, on lawns, in May and October.

PAINTED BUNTING *(Passerina ciris)*
Accidental visitant from the south. All old records were assumed to be escaped cage birds. Three or four recent records, including one collected specimen, are probably wild birds.

DICKCISSEL *(Spiza americana)*
Now a regular, but rare fall migrant on the outer coast, chiefly in October. Several records of wintering birds at feeders, principally in New Jersey, and elsewhere inland.

EVENING GROSBEAK *(Hesperiphona vespertina)*
In recent years a very common winter visitant at feeding stations, chiefly inland; also in New Jersey, particularly wherever box elder or ash-leaved maple occurs, sometimes in good-sized flocks. Rare and irregular on the coast.

PURPLE FINCH *(Carpodacus purpureus)*
Uncommon and local summer resident, preferring to nest in plantings of ornamental conifers, and occasionally in pitch pine woods. As a migrant and winter visitant, irregular in numbers and exceedingly erratic in its time of stay, some years common in fall and usually common in spring. Ordinarily rare and erratic in winter.

HOUSE FINCH *(Carpodacus mexicanus)*
Introduced from the west. Now established and resident in three main colonies on Long Island: Babylon, Westbury and Hewlett. Prefers to nest in ornamental conifers, chiefly spruces. Apparently a new colony has become established in the Greenwich, Connecticut area. Increasing and spreading to the surrounding country, wherever ornamental spruces are found, such as on estates and nurseries, and common at feeding stations in these areas. Reported from New Jersey and Westchester County, but still very rare and local.

PINE GROSBEAK *(Pinicola enucleator)*
Rare and irregular winter visitant, chiefly inland, occasionally appearing in flight years, in small flocks at feeding stations, and occurring where sumac, ash, mountain ash and apples are present.

EUROPEAN GOLDFINCH *(Carduelis carduelis)*
Introduced from the Old World. Very rare to casual visitant anywhere or at anytime in the region. Perhaps some or most records of single individuals in recent years in and near New York City are escaped cage birds. However, a small colony until recently existed in the Massapequa, Long Island area, now greatly reduced in numbers.

HOARY REDPOLL *(Acanthis hornemanni)*
Accidental winter visitant from the Arctic. One old collected specimen. Recently one or two sight reports from northern New Jersey, of adults seen in with flocks of *A. flammea* by experienced and competent observers, are probably correct.

COMMON REDPOLL *(Acanthis flammea)*
Irregular winter visitant, absent or very rare some years, common to really abundant in others. Prefers alders and birches, also weedy fields, and to a lesser extent evergreens. Occasionally in great flight years the larger, darker, and heavier billed race, *rostrata* has been taken in with flocks of the common *flammea,* but sight records are not reliable.

PINE SISKIN *(Spinus pinus)*
Irregular visitant, chiefly in fall and winter, sometimes rare, in certain years really abundant in fall, and usually present the following spring well into May, if the preceding fall produced a large flight.

AMERICAN GOLDFINCH *(Spinus tristis)*
Permanent resident in varying numbers, subject to marked fluctuations. Regular in spring and fall, common to abundant some seasons, rare in others. Irregular in winter, depending greatly upon the food supply. Common summer resident in open country.

RED CROSSBILL *(Loxia curvirostra)*
The most erratic and irregular of the local birds. Recorded in every month of the year. The eastern race, *minor,* is primarily a rare winter visitant, sometimes occurring in large numbers during flight years. Prefers the cones of pitch and black pines along the coast. Has bred at least twice. Both *pusilla,* the race from the northeast, and *sitkensis,* from the far northwest, have occurred during several flights, and a number of specimens, particularly *sitkensis,* have been collected locally.

WHITE-WINGED CROSSBILL *(Loxia leucoptera)*
Rare and irregular winter visitant, but occasionally occurring in flocks during flight years. Much less frequent than the Red Crossbill. Prefers the cones of hemlocks, especially inland, also pitch and black pines on the coast.

GREEN-TAILED TOWHEE *(Chlorura chlorura)*
Accidental visitant from the west. Never collected, but seen well on several occasions (same bird) in New Jersey, and undoubtedly correctly identified.

RUFOUS-SIDED TOWHEE *(Pipilo erythrophthalmus)*
Very common summer resident, especially on the coastal plain, nesting in dry open woods and in wooded clearings, with an abundance of undergrowth, in scrub pine and oak, and in dense thickets among the sand dunes. Abundant migrant. Rare but regular in winter. Two recently collected specimens of the Great Plains race, *arcticus,* were taken on the coast of New Jersey and Long Island. This subspecies belongs to the *maculatus* group, formerly considered a separate species, the Spotted Towhee.

LARK BUNTING *(Calamospiza melanocorys)*
Accidental visitant from the west. Two old specimens from Long Island.

IPSWICH SPARROW *(Passerculus princeps)*
Now an uncommon but regular migrant and winter visitant along the outer coast. Formerly more common. Found almost exclusively on the sand dunes and beaches.

SAVANNAH SPARROW *(Passerculus sandwichensis)*
The local breeding race, *savanna*, is a very common migrant in open country, particularly on the coast, and uncommon but regular in winter. Fairly common breeder on the coast, nesting in the sand dunes and filled-in grassy areas around the salt marshes. Rare and local summer resident inland, nesting in grassy fields and pastures. The race *labradorius* is, perhaps, a regular migrant on the coast and occurring rarely in winter. At least a dozen specimens collected, mostly from the south shore of Long Island.

GRASSHOPPER SPARROW *(Ammodramus savannarum)*
Now a greatly decreased and uncommon summer resident, because of the elimination of its nesting sites by building developments, notably the Hempstead Plains on Long Island. Breeds in dry grassy fields. Rare as a migrant.

BAIRD'S SPARROW *(Ammodramus bairdii)*
Accidental visitant from the west. One old collected specimen from Long Island.

HENSLOW'S SPARROW *(Passerherbulus henslowii)*
Uncommon to rare and decidedly local summer resident. Nests in both dry and moist situations, in open grassy areas with weeds and scattered bushes.

SHARP-TAILED SPARROW *(Ammospiza caudacuta)*
The nominate race is a common summer resident along the coast. Nests exclusively in the salt marshes, favoring the drier portions. Rare, but regular in winter. The race *subvirgata*, is a fairly common migrant on the coastal salt marshes. The races *nelsoni*, and *altera*, unlike the preceding two subspecies, nest to the northwest in inland marshes. The status of these two subspecies is still relatively little known, but both have been collected locally on salt and inland fresh water marshes, chiefly in fall. Further collecting is desirable to clarify their status.

SEASIDE SPARROW *(Ammospiza maritima)*
Common summer resident along the coast, but local at the eastern end of Long Island. Nests exclusively in the salt marshes, favoring the wetter portions. Rare, but regular in winter.

VESPER SPARROW *(Pooecetes gramineus)*
Uncommon and local summer resident, decreasing for the same reason as the Grasshopper Sparrow: elimination of its favored haunts by building developments. Nests in dry fields and pastures. Fairly common migrant. Rare but regular in winter, chiefly along the coast.

LARK SPARROW *(Chondestes grammacus)*
Rare but regular fall migrant on the outer coast, preferring dry sandy fields. Casual in spring.

BACHMAN'S SPARROW *(Aimophila aestivalis)*
Accidental visitant, breeding as far north as Ohio and southwestern Pennsylvania. One specimen taken in northern New Jersey, and one sight record from western Long Island, the latter seen by several observers previously familiar with the species.

SLATE-COLORED JUNCO *(Junco hyemalis)*
Abundant migrant and common in winter.

OREGON JUNCO *(Junco oreganus)*
Casual late fall and winter visitant from the west. One specimen collected in Westchester County is the race *montanus*. Another recently collected in New Jersey has been determined to be the same. Winter individuals have been seen at feeders in several localities.

TREE SPARROW *(Spizella arborea)*
Very common winter visitant in open country.

CHIPPING SPARROW *(Spizella passerina)*
Common summer resident, nesting chiefly around farms, surburban yards with some evergreen shrubbery, and generally in most of the settled rural country. Very common as a migrant. Very rare in winter, but reported each year.

CLAY-COLORED SPARROW *(Spizella pallida)*
Very rare fall visitant from the west. In recent years recorded annually on the coast by competent observers. One recently collected specimen from western Long Island.

BREWER'S SPARROW *(Spizella breweri)*
Accidental fall visitant from the west. Never collected locally, but several recent Long Island sight records on the south shore by competent observers may be correct.

FIELD SPARROW *(Spizella pusilla)*
Common summer resident, nesting in scrubby fields. Very common migrant. Regular and sometimes not uncommon in winter.

HARRIS' SPARROW *(Zonotrichia querula)*
Accidental visitant from the west. Never collected, but at least three sight records from the region by experienced observers.

WHITE-CROWNED SPARROW *(Zonotrichia leucophrys)*
Fairly common migrant, preferring lawns with hedges and thickets. Very rare in winter.

GOLDEN-CROWNED SPARROW *(Zonotrichia atricapilla)*
Accidental visitant from the west. Never collected, but one individual re-

mained at Jones Beach for nearly an entire winter, and was seen by numerous observers.

WHITE-THROATED SPARROW *(Zonotrichia albicollis)*
Abundant migrant, particularly in fall. Locally common in winter near the coast.

FOX SPARROW *(Passerella iliaca)*
A migrant in varying numbers, some years scarce, in others very common, often in large flocks. Uncommon but regular in winter.

LINCOLN'S SPARROW *(Melospiza lincolnii)*
Uncommon to rare, but regular migrant. Shy and secretive, it favors thickets, hedgerows, and bushy borders of swamps and ponds, but may be observed readily on open lawns if the necessary cover is available.

SWAMP SPARROW *(Melospiza georgiana)*
Common summer resident, nesting in marshes, swamps, and along wooded streams and ponds, but rare on the coastal plain, and on Long Island generally. Very common migrant throughout, but uncommon and local in winter, found chiefly near the coast.

SONG SPARROW *(Melospiza melodia)*
Very common summer resident. Abundant migrant, but never in very large flocks, such as occur with the Junco or White-throated Sparrow. Locally common in winter, especially near the coast. The race *atlantica,* is said to nest on the coastal barrier islands from Long Island south, but further collecting is needed for definite proof. The few specimens taken locally appear to be intermediates between *atlantica* and the common *melodia.*

LAPLAND LONGSPUR *(Calcarius lapponicus)*
Uncommon and local, but regular winter visitant, occasionally in good-sized flocks on the south shore of Long Island. Rarer on the New Jersey coast, and very rare inland. Prefers short grassy fields.

CHESTNUT-COLLARED LONGSPUR *(Calcarius ornatus)*
Accidental visitant from the west. Recorded only from Long Island.

SNOW BUNTING *(Plectrophenax nivalis)*
A migrant and winter visitant in varying numbers. Occasionally very common on the coast, favoring the beaches, sand dunes, and filled-in grassy areas. Usually very rare and local inland, but appears sometimes after winter storms, and apparently a regular late fall migrant on mountain summits, and exposed ridges, being found on bare rock and small grassy areas.

GLOSSARY OF TERMS

OCCURRENCE AND RELATIVE ABUNDANCE

OCCURRENCE

Regular	recorded annually
Irregular	not recorded annually, but more than 12 records
Casual	from 7 to 12 records
Accidental	from 1 to 6 records

RELATIVE ABUNDANCE

Abundant	over 50 individuals per day (usually large flocks)
Very common	from 20 to 50 per day
Common	more than 12, but less than 20 per day
Fairly common	6 to 12 per day
Uncommon	1 to 6 per day
Rare	2 to 6 per season
Very rare	usually less than 2 per season (sometimes not recorded each year)

Two examples of the above would be: Philadelphia Vireo, rare, but regular fall migrant; occurring annually, but only 2 to 6 per season. Common Redpoll, irregular, but occasionally abundant winter visitant; not occurring every year, however, may be found in flocks of 500-1,000 during flight periods.

Note that the terms of relative abundance are used here in a purely arbitrary sense and that no two individuals would agree with all of the examples cited. The status of many species is in a constant state of flux and varies from year to year.

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